DOCUMENT RESUME

ED 123 071 SE 020 635

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TITLE Individualized Math Problems in Geometry. Oregon Vo-Tech Mathematics Problem Sets.
INSTITUTION Oregon Math Education Council, Salem.; Oregon State Dept. of Education, Salem. Career and Vocational Education Section.
PUB DATE 74
NOTE 105p.; For related documents, see SE 020 628-648
AVAILABLE FROM Continuing Education Publications, P.O. Box 1491, Portland, Oregon 97207

EDRS PRICE MF-$0.83 Plus Postage. HC Not Available from EDRS.
DESCRIPTORS *Geometry; Individualized Instruction; *Instructional Materials; Mathematical Applications; Mathematics Education; Measurement; *Problem Sets; Secondary Education; *Secondary School Mathematics; *Vocational Education
IDENTIFIERS *Oregon Vo Tech Math Project

ABSTRACT

This is one of eighteen sets of individualized mathematics problems developed by the Oregon Vo-Tech Math Project. Each of these problem packages is organized around a mathematical topic and contains problems related to diverse vocations. Solutions are provided for all problems. The volume contains problems in applied geometry. Measurement of perimeters, areas, and volumes, as well as angle measurement and the use of the Pythagorean Theorem, form the basis for most of the problems included. Problems are drawn from eleven vocational areas: fire and police science, aviation mechanics, industrial mechanics, forest products, auto mechanics, electronics, drafting, machine tools, food processing, forestry, and agriculture. (SD)

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ILS INDIVIDUALIZED LEARNING SYSTEMS

Individualized Math Problems in

Geometry

Oregon Vo-Tech Mathematics Problem Sets

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Individualized Learning Systems

MATHEMATICS

Geometry

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The host school for this project was Linn-Benton Community College, Albany, Oregon. The project was funded by two sources: the Oregon Math Education Council (OMEC) and through Part D Federal Funds, under contract for the Division of Instructional Support-Career Education, Oregon State Department of Education, under the authority of the Vocational Education Act of 1963 as amended in 1968. Questions regarding use, reproduction, or availability of these materials should be addressed to the Curriculum Coordinator, State Department of Education, 942 Lancaster Drive NE., Salem, Oregon 97310.

A. Problems with Solutions

1. A water tank is 24 feet in diameter. If it has 14.2 feet of water in it, how many gallons does it contain?

Solution:

You need to determine the volume of the water in the tank, and multiply that by the number of gallons per cubic foot. 7.48 gallons = 1 cubic foot.

$V = \pi r^2 h$

$= (3.14)(12 \text{ feet})^2 (14.2 \text{ feet})$
$= 6{,}423.93$ cubic feet

$$\left(\frac{6{,}423.93 \text{ cu-ft}}{1}\right)\left(\frac{7.48 \text{ gals}}{\text{cubic-feet}}\right) = 48{,}050.9 \text{ gallons}$$

So, the tank holds 48,051 gallons

B. Problems without Solutions

2. How many 2-inch water lines would be required to carry the output of one 6-inch line?

B. Problems without Solutions (continued)

3. A new company has built outside the city limits and the insurance company has requested that the company maintain a water storage tank in addition to the regular water system. The manager wishes to find the amount of water that could be obtained by water runoff from the roof. How many gallons of water will drain from the 480 ft x 120 ft roof per year if the annual rainfall is 26 inches? (One gallon equals 231 cubic inches.)

Complete Solutions to B Problems

2. You need to compute the cross-sectional of each size water line, and then determine how many of the 2-inch lines equal one 6-inch line.

$$A = \pi r^2$$

for 2-inch line

$A = \pi (1)^2$

$A = \pi$

for 6-inch line

$A = \pi (3)^2$

$A = 9\pi$

Therefore, it will take nine 2-inch lines to carry the output of one 6-inch line.

3. You need to find the volume of a rectangular solid that is 480 feet by 120 feet by 26 inches.

$$(480 \text{ feet}) \left(\frac{12 \text{ inches}}{1 \text{ foot}} \right) = 5{,}760 \text{ inches}$$

$$(120 \text{ feet}) \left(\frac{12 \text{ inches}}{1 \text{ foot}} \right) = 1{,}440 \text{ inches}$$

$V = l \, w \, h$

$V = (5760 \text{ inches})(1440 \text{ inches})(26 \text{ inches})$

$V = 215{,}654{,}400$ cubic inches

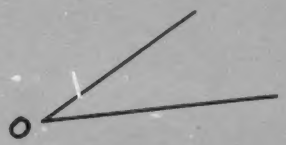
There are 231 cubic inches in one gallon.

$(215{,}654{,}400 \text{ cu-in})(1 \text{ gallon}/231 \text{ cu-in}) = 933{,}568.8$ gallons

So, there will be about 930,000 gallons of runoff.

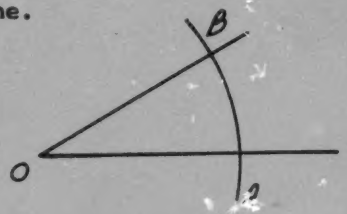
A. Problems with Solutions

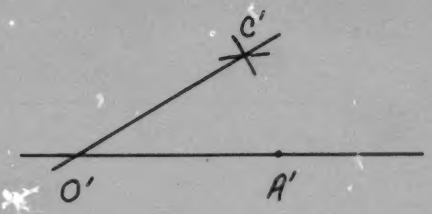
1. Draw an angle equal to a given angle.



Solution:

Draw a line segment and locate a point O' on it. Locate any other point A'. With radius O'A', strike off an arc with center O'. Do the same on the given angle - that is - strike off the arc with center O. This will locate points A and B on the given angle. Copy the measure AB on compasses and draw arc with center A'. This will locate C'. The angle A'O'C' is the required one.

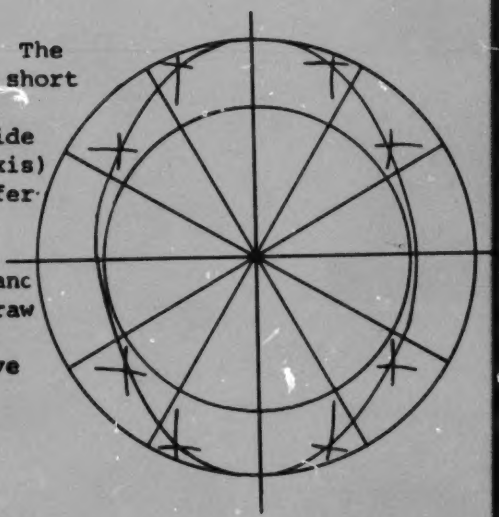




2. Draw an "ellipse" when the long and short diameters are given.

Solution:

The figure shows concentric circles. The diameter of the inside circle is the short diameter (minor axis) of the desired "ellipse". The diameter of the outside circle is the long diameter (major axis) of the "ellipse". Divide the circumference of the circles into a number of equal divisions as shown. From the intersections of the division lines and the circumferences of the circles, draw pairs of lines perpendicular to each other and to the axes. A smooth curve through the intersections of these lines will describe the "ellipse".

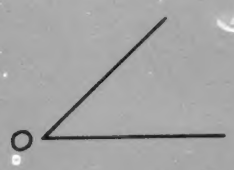


B. Problems without Solutions

3. For aircraft layout work, the following skills in geometric construction are necessary.

Bisect the segment 1.

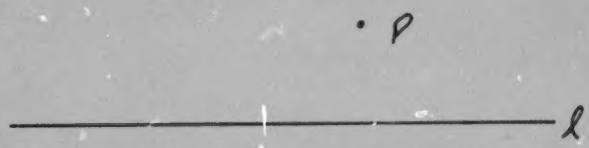
4. Bisect the angle at O.



B. Problems without Solutions (continued)

5. Construct a perpendicular from a given point on a line.

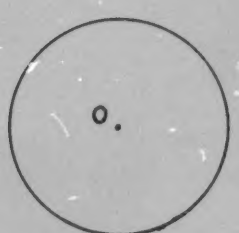
6. Draw a line perpendicular to a given line from a given point (not on the line).



B. Problems without Solutions (continued)

7. Divide a line segment into any number of equal parts. Try five.

8. Divide a circle into six equal parts.



B. Problems without Solutions (continued)

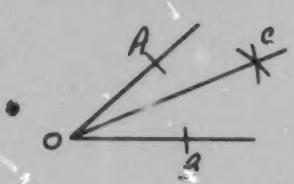
9. Find the center of a given circle.

Complete Solutions to B Problems

3.

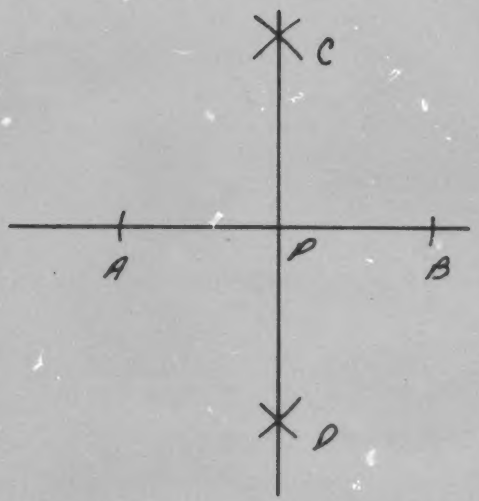
With the end points of l serving as centers of arcs, strike off arcs with radius equal to the measure of segment l, locating points A and B. The segment joining A and B cuts the segment l at its midpoint M.

4.



Using O as the center of an arc, strike off equal segments OA and OB. Using the points A and B in turn as the centers of arcs with fixed radius, strike off arcs locating the point C. The segment joining C to O will be the bisector of the angle AOC.

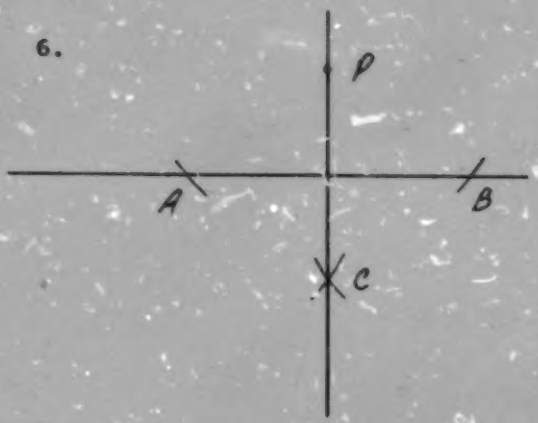
5.



Strike off an arc about P to locate points A and B, each equidistant from P. Then with radius greater than AP, strike off equal arcs about A and about B to locate the points C and D. The segment CD though P is the required perpendicular.

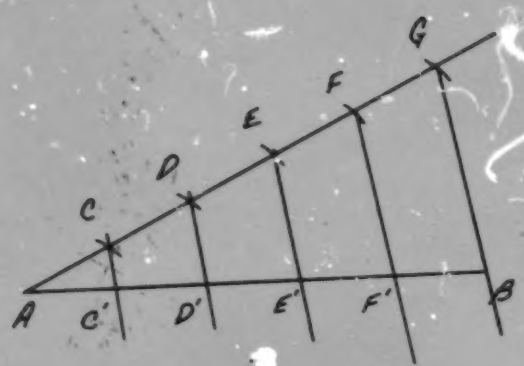
Complete Solutions to B Problems (continued)

6.



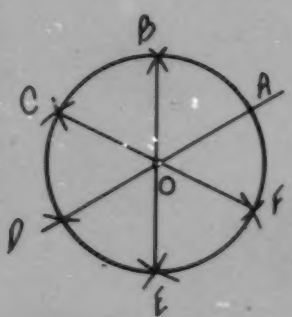
With an arc of radius greater than the distance from P to l, strike off an arc with center P and locate points A and B. With the same radius, strike off arcs from each of A and B to locate C. PC is the required perpendicular.

7.



Suppose it is desired to divide the segment AB into five equal parts. Lay off a line segment through A and with compasses mark off five equal measure segments locating points C, D, E, F, and G. Join G to B. Construct parallels to GB through each of F, E, D, and C to locate points F', E', D', and C'. These points divide AB into five equal parts.

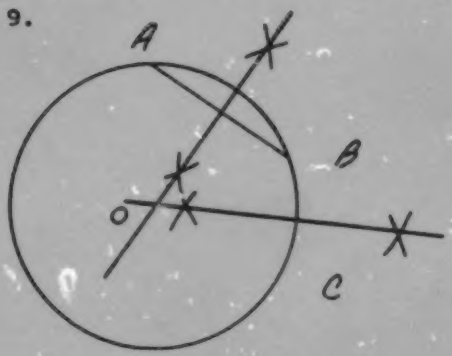
8.



Locate any point A on the circle. Strike off arcs with radius OA, the same as that of the circle, using each of the newly found points as center. This will locate points B, C, D, E, and F. Pairs of these points are end points of diameters of the circle and when drawn, divide the circle into six parts.

Complete Solutions to B Problems (continued)

9.



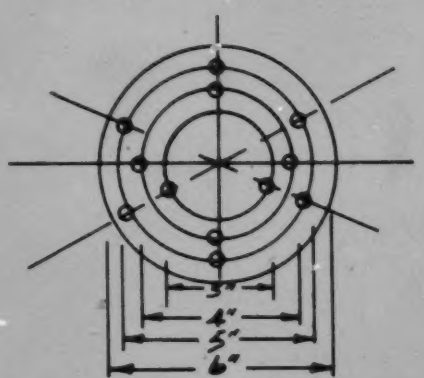
Locate any three points A, B, and C on the circle and form the chords AB and BC. Construct a perpendicular bisector to each of these chords. The place where they cross inside the circle will be the center.

1. A piece of a cast iron disc was found to have exactly the shape shown. By construction, find the center of the disc and then reproduce the disc on your paper.

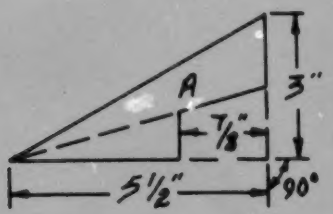
2. By construction, lay out the center for a hole midway between two end holes of a drill jig. Use any center distance you want.

3. Ten equally spaced holes 3/8" in diameter are to be punched along the edge of a piece of stock with the centers of the extreme holes 10" apart. Lay out the holes by construction.

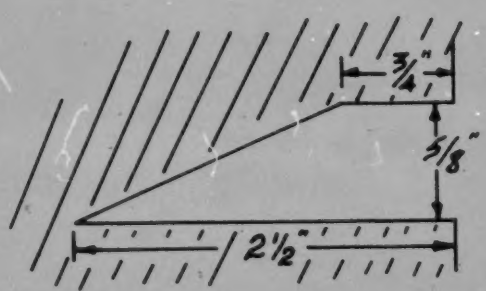
4. Lay out a circular plate as shown with 3, one quarter inch holes in the first circle; 4, three-eights holes in the second circle; 6 one-half inch holes in the third circle.



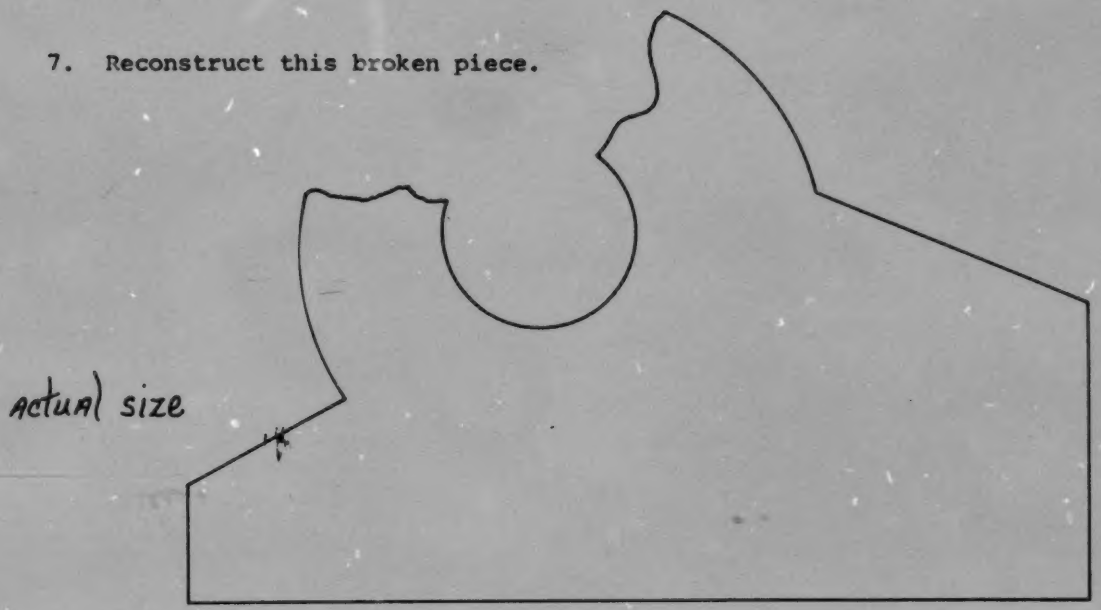
5. In the layout in the illustration, it is necessary to bisect the angle to get the cut at A. Lay out the piece by construction.



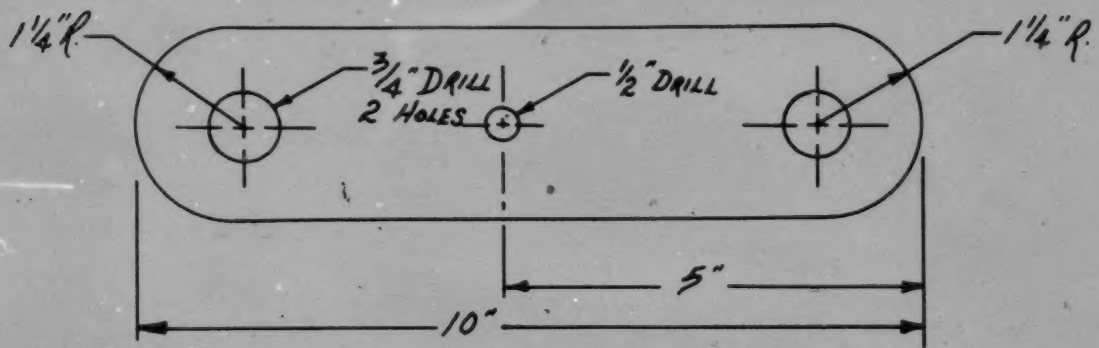
6. The drawing is of a 5/8" thick gage used to check the grinding angle on the blade of a power shear. Lay out a new gage with the same angle to be used on a 7/8" thick blade.



7. Reconstruct this broken piece.

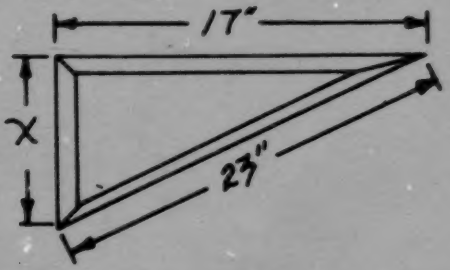


8. Construct this piece life size.



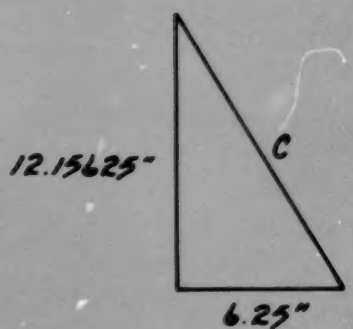
A. Problems with Solutions

1. An angle iron bracket is made from the sketch below. What is the missing dimension?



Solution:

$x^2 + (17 \text{ in})^2 = (23 \text{ in})^2$
$x^2 + 289 \text{ sq in} = 529 \text{ sq in}$
$x^2 = 240 \text{ sq in}$
$x = \sqrt{240 \text{ sq in}}$
$x = 15.5 \text{ in}$



2. In a certain piece of work, there is need for a right triangular bracket made from angle iron. The piece is to be 12 5/32" high and 6 1/4" at the base. How long must the third piece be to complete the construction?

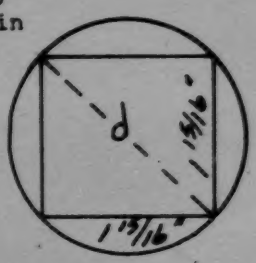
Solution:

$C^2 = (6.25 \text{ in})^2 + (12.15625 \text{ in})^2$
$C^2 = 39.06 \text{ sq in} + 147.77 \text{ sq in}$
$C^2 = 186.83 \text{ sq in}$
$C = \sqrt{186.83 \text{ sq in}}$
$C = 13.67 \text{ in} \approx 14 \text{ in}$

3. We need to mill a square end on a round piece of stock. What should the diameter of the stock be in order to mill a square end 1 15/16" on a side?

Solution:

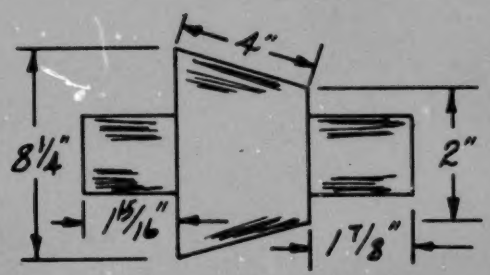
$d^2 = (1\ 15/16 \text{ in})^2 + (1\ 15/16 \text{ in})^2$
$d^2 = (1.9375 \text{ in})^2 + (1.9375 \text{ in})^2$
$d^2 = 3.7539 \text{ sq in} + 3.7539 \text{ sq in}$
$d^2 = 7.5078 \text{ sq in}$
$d = \sqrt{7.5078 \text{ sq in}}$
$d = 2.740 \text{ in}$



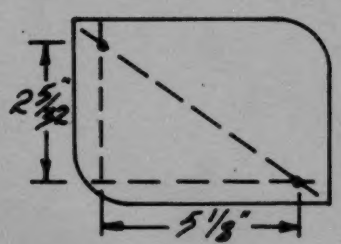
B. Problems without Solutions

4. The longest and shortest sides of a triangular piece of metal are 5" and 7 1/4". How long must the third side be in order for the piece to have a right angle?

5. Compute the overall length of the piece of work in the figure.

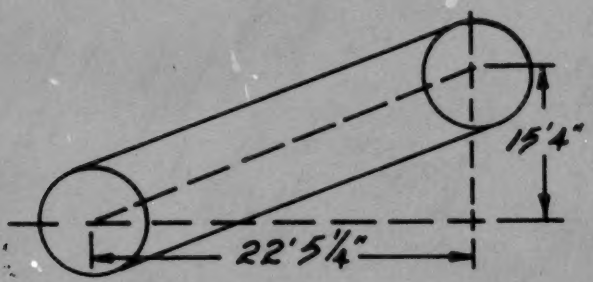


6. What is the straight line distance between the bolt holes in the plate?

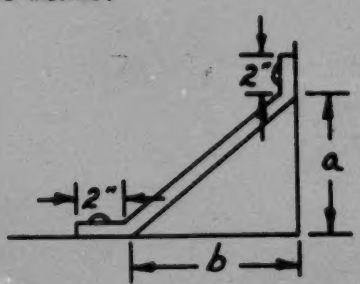


B. Problems without Solutions (continued)

7. In the figure, pulley A is 15' 4" above and 22' 5 1/4" to the right of pulley B. Find the distance between their centers.



8. The brace in the figure is constructed from 1/4" sheet metal. Find the length of the brace needed in the sketch if a = 14" and b = 17". Make an allowance of 1/2 the thickness of the metal for the bends.



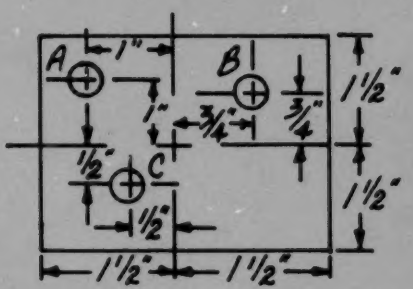
B. Problems without Solutions (continued)

9. On the template as illustrated, find:

   (a) The distance between the centers of holes A and B.

   (b) The distance between the centers of holes B and C.

   (c) The distance from the center of hole A to the nearest corner.



B. Problems without Solutions (continued)

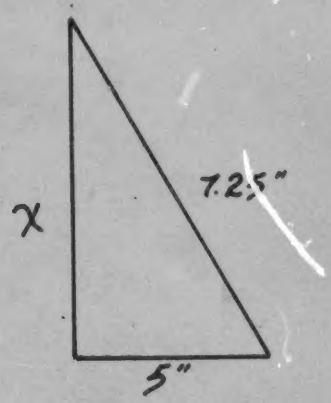
10. The 100 foot smokestack for a factory is to be held in place by 5 guy wires attached 3/4 of the way up the stack and fastened to concrete blocks on a level with the bottom of the stack, each 70' distance from it. Allowing a total of 30' for fastening, how many feet of wire will be required?

11. An engine shaft is centered 9' below and 3' to the left of a line shaft. Find the distance between the centers of the two shafts.

B. Problems without Solutions (continued)

12. In building a boiler, reinforcement was fastened to the boiler with square headed bolts 7/8" on a side. If the heads are to be countersunk, what size should the hole be to allow for 1/32" clearance around the bolt heads?

Complete Solutions to B Problems



4. $x^2 + (5 \text{ in})^2 = (7.25 \text{ in})^2$

$x^2 + 25 \text{ sq in} = 52.5625 \text{ sq in}$

$x^2 = 27.5625 \text{ sq in}$

$x = \sqrt{27.5625 \text{ sq in}}$

$x = 5.25 \text{ in} = 5\ 1/4 \text{ in}$

5. $d = \frac{8\ 1/4" - 2"}{2} = \frac{6\ 1/4"}{2} = 3\ 1/8" = 3.125 \text{ in}$

$x^2 + d^2 = (4 \text{ in})^2$

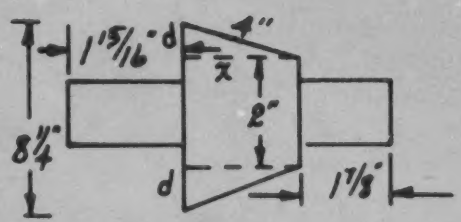
$x^2 + (3.125 \text{ in})^2 = (4 \text{ in})^2$

$x^2 + 9.766 \text{ sq in} = 16 \text{ sq in}$

$x^2 = 6.234 \text{ sq in}$

$x = \sqrt{6.234 \text{ sq in}}$

$x = 2.497 \text{ in}$



Total length = 1 15/16" + 2.497" + 1 7/8"
= 1.9375" + 2.497" + 1.875"
= 6.3095 in

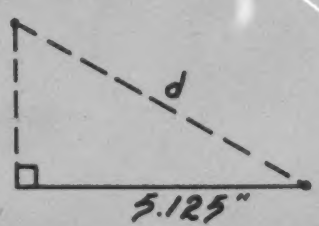
6. $d^2 = (2.156 \text{ in})^2 + (5.125 \text{ in})^2$

$d^2 = 4.649 \text{ sq in} + 26.266 \text{ sq in}$

$d^2 = 30.914 \text{ sq in}$

$d = \sqrt{30.914 \text{ sq in}}$

$d = 5.560 \text{ in}$



Complete Solutions to B Problems (continued)

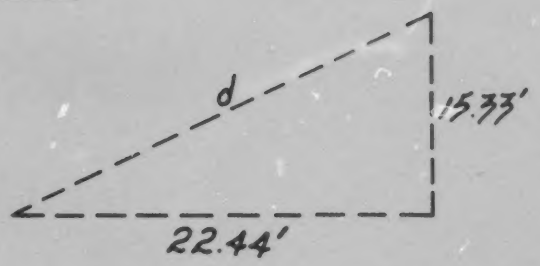
7. $d^2 = (15.33 \text{ ft})^2 + (22.44 \text{ ft})^2$

$d^2 = 235.0 \text{ sq ft} + 503.6 \text{ sq ft}$

$d^2 = 738.6 \text{ sq ft}$

$d = \sqrt{738.6 \text{ sq ft}}$

$d = 27.18 \text{ ft} \approx 27 \text{ ft } 2 \text{ in}$



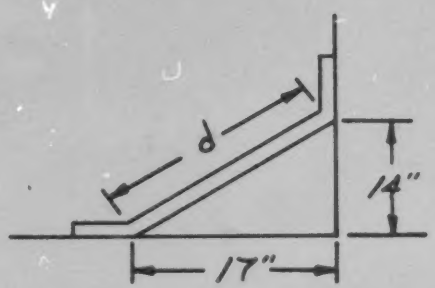
8. $d^2 = (14 \text{ in})^2 + (17 \text{ in})^2$

$d^2 = 196 \text{ sq in} + 289 \text{ sq in}$

$d^2 = 485 \text{ sq in}$

$d = \sqrt{485 \text{ sq in}}$

$d = 22.0 \text{ in}$



Total length needed:
22.0 in + 2 in + 2 in + (1/2)(1/4 in) = 26 1/8 in

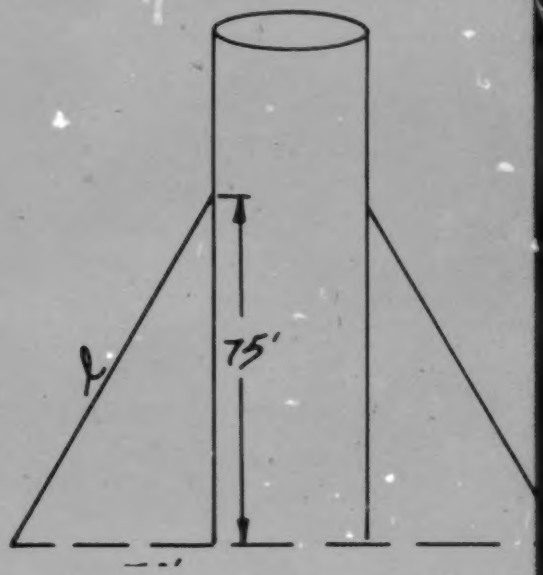
9. (a) $AB^2 = (0.25 \text{ in})^2 + (1.75 \text{ in})^2$
$AB^2 = 0.0625 \text{ sq in} + 3.0625 \text{ sq in}$
$AB^2 = 3.125 \text{ sq in}$
$AB = 1.77 \text{ in}$

(b) $BC^2 = (1.25 \text{ in})^2 + (1.25 \text{ in})^2$
$BC^2 = 1.5625 \text{ sq in} + 1.5625 \text{ sq in}$
$BC^2 = 3.125 \text{ sq in}$
$BC = 1.77 \text{ in}$

(c) $d^2 = (0.5 \text{ in})^2 + (0.5 \text{ in})^2$
$d^2 = 0.25 \text{ sq in} + 0.25 \text{ sq in}$
$d^2 = 0.5 \text{ sq in}$
$d = 0.707 \text{ in}$

GEOMETRY
PYTHAGOREAN THEOREM
Level 2

Complete Solutions to B Problems



10. $l^2 = (75 \text{ ft})^2 + (70 \text{ ft})^2$

$l^2 = 5{,}625 \text{ sq ft} + 4{,}900 \text{ sq ft}$

$l^2 = 10{,}525 \text{ sq ft}$

$l = \sqrt{10{,}525 \text{ sq ft}}$

$l = 102.6 \text{ ft}$

Length of wire needed:
$5(102.6 \text{ ft}) + 30 \text{ ft} = 513 \text{ ft} + 30 \text{ ft}$
$= 543 \text{ ft}$

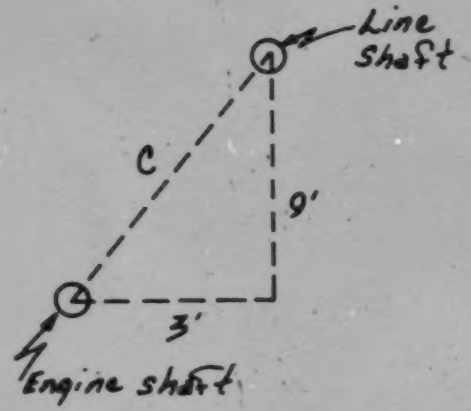
11. c = center to center distance

$c^2 = (9 \text{ ft})^2 + (3 \text{ ft})^2$

$c^2 = 81 \text{ sq ft} + 9 \text{ sq ft}$

$c^2 = 90 \text{ sq ft}$

$c = 9.5 \text{ ft}$



12. $c^2 = (7/8 \text{ in})^2 + (7/8 \text{ in})^2$

$c^2 = (0.875 \text{ in})^2 + (0.875 \text{ in})^2$

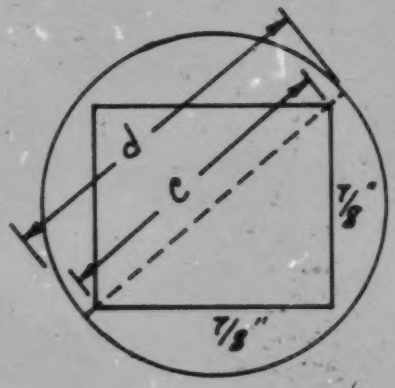
$c^2 = 0.766 \text{ sq in} + 0.766 \text{ sq in}$

$c^2 = 1.532 \text{ sq in}$

$c = \sqrt{1.532 \text{ sq in}}$

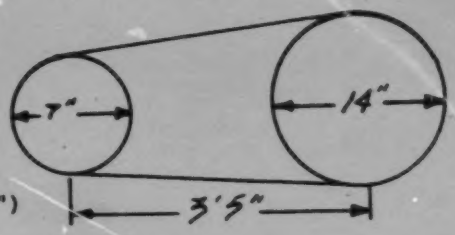
$c = 1.238 \text{ in}$

d = diameter of hole
= 1.238" + 2(1/32")
= 1.238 in + 0.0625 in
= 1.301 in



A. Problems with Solutions

1. Two pulleys whose diameters are 7" and 14" are encircled by a belt. The centers of the pulleys are arranged horizontally 3' 5" apart and the sag required for proper adjustment of the belt requires an additional 0.1 foot of belt. How long must the belt be? (approximately)



Solution:

Formula needed $C = \pi d$

Length of belt on 7" pulley =
$(1/2)(\pi)(7") = (1/2)(3.14)(7")$
$= 10.99$ in

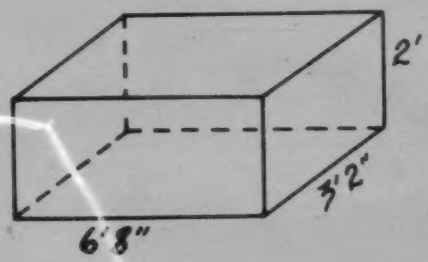
Length of belt on 14" pulley =
$(1/2)(\pi)(14") = (1/2)(3.14)(14")$
$= 21.98$ in

Total length = 2(3 ft 5 in)+0.1 ft + 10.99 in + 21.98 in
= 2 (41 in) + 1.2 in + 10.99 in + 21.98 in
= 116.17 in = 9 ft 8.17 in

2. Approximately how many square feet of sheet metal are needed to construct a box without a top, its dimensions are 6' 8" by 3' 2" by 2'?

Solution:

Formula needed $A = lw$



Area of ends = (2 ft)(3 ft 2 in)
= (24 in)(38 in)
= 912 sq in

Area of back and front =
(2 ft)(6 ft 8 in)=
(24 in)(80 in) =
1,920 sq in

Area of bottom = (6 ft 8 in)(3 ft 2 in)
= (80 in)(38 in) = 3,040 sq in

Total area = 2(912 sq in) + 2(1,920 sq in) + 3,040 sq in
= 1,824 sq in + 3,840 sq in + 3,040 sq in
= 8,704 sq in
$= \frac{8{,}704 \text{ sq in}}{144 \text{ sq in/sq ft}}$
= 60.4 sq ft

A. Problems with Solution (continued)

3. A circular vat with a radius of 18" is required to have a capacity of 350 gallons. What must be the height of the vat ?

Solution:

Formula needed $V = \pi r^2 h$

$$V = \frac{350 \text{ gal}}{7.48 \text{ gal/cu ft}} = 46.8 \text{ cu ft}$$

$$46.8 \text{ cu ft} = \pi (18 \text{ in})^2 h$$

$$46.8 \text{ cu ft} = (3.14)(1.5 \text{ ft})^2 h$$

$$46.8 \text{ cu ft} = (7.065 \text{ sq ft})h$$

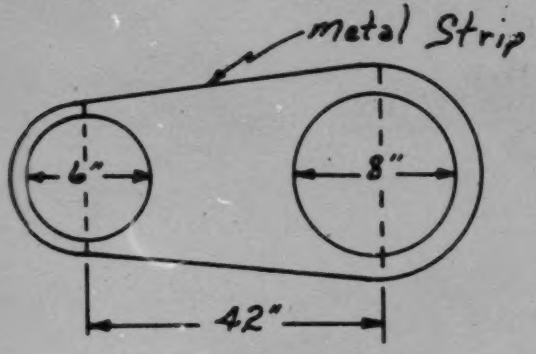
$$h = \frac{46.8 \text{ cu ft}}{7.065 \text{ sq ft}} = 6.62 \text{ ft}$$

B. Problems without Solutions

4. A certain pipe joint is to be made by slipping a sleeve over the two pipe ends and welding it in place. The two pipes to be joined have a 3 1/4" OD. If the sleeve is to be made by bending a piece of sheet metal, approximately how long a piece of sheet metal will we need to do the job?

B. Problems without Solutions (continued)

5. An 8" sprocket is connected to a 6" sprocket by a chain. A chain guard is to be built allowing 1" clearance around the chain. A strip of metal 1 3/4 inches wide is to be bent to form the edge of the guard. Approximately how long must the strip be? (see drawing)



6. Because of the manner in which it was mounted, it was impossible to measure with accuracy the diameter of the flywheel in an engine. By using a steel tape, the circumference was measured to be 320 cm. Find the diameter in inches.

B. Problems without Solution (continued)

7. It's inventory time and you are assigned to inventory the parts shack. During the inventory, you come across a coil of flex hose containing 26 coils. The outside diameter of the coil is 38" and the inside diameter of the coil is 16". What should you record on your inventory sheet for the number of feet of hose in the coil?

8. A 12" pulley that makes 50 rpms is to be connected to a second pulley so that the belt speed is 5 ft/sec. What size does the second pulley need to be?

B. Problems without Solutions (continued)

9. A cubic bin, without a top, 5' on an edge is to be constructed. Material for the bin costs $2.89 per square foot. It is estimated that it will take 6 hours 45 minutes at $5.83 an hour to construct the bin. What will the approximate total cost of the bin?

10. Part of the construction of a cylindrical tank used to hold resin is coating the inside with a corrosion preventative. The tank has a diameter of 8' 3" and a height of 6'. If 1 gallon of the corrosion preventative will cover 3 sq ft, how many gallons will it take to coat the tank?

B. Problems without Solutions (continued)

11. A round steel rod 1 1/4" in diameter can safely bear a pull of 16,000 lbs/sq in. What must the diameter be to pull 25,000 lbs.

12. An oil container in the shape of an inverted pyramid has a top of a rectangle 5' 6" x 3' and a height of 4.5'. What is the volume of the tank?

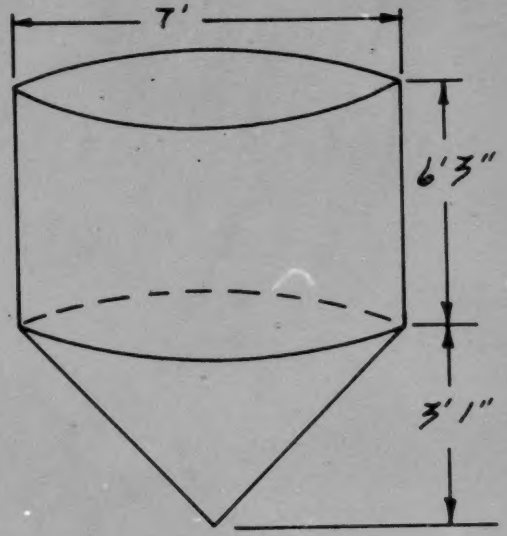
B. Problems without Solutions (continued)

13. Approximately, how much will it cost for sheet metal to construct a cylindrical tank, with a bottom and top, that has a diameter of 10' 6" and a height of 12' 8" if sheet metal costs $2.335 per sq foot?

14. 110 gallons of liquid was pumped from a spherical tank with a radius of 4 feet. How many gallons of liquid are left in the tank? (1 cu ft = 7.48 gal)

B. Problems without Solutions (continued)

15. Plywood glue is stored in the tank pictured here. How many cubic feet of glue are in the tank?



16. If the circumference of a cylindrical tank 25' high is 40', how many gallons of resin will the tank hold? (1 cubic foot = 7.48 gal)

B. Problems without Solutions (continued)

17. Sawdust is dumped into a rectangular opening of length 17 1/2" and width 10 5/8". In order to increase production by 12.2%, the area of the opening must be increased 17%. However, the length must remain unchanged. By what amount must the width be changed in order to increase production by the given amount?

18. A spherical tank holding 1200 gallons of water is to be placed in a building. The tank is to be mounted on a base which will raise it 1' 3" off the floor of the building. The building's ceiling is only 10' high. Will the tank fit?

B. Problems without Solutions (continued)

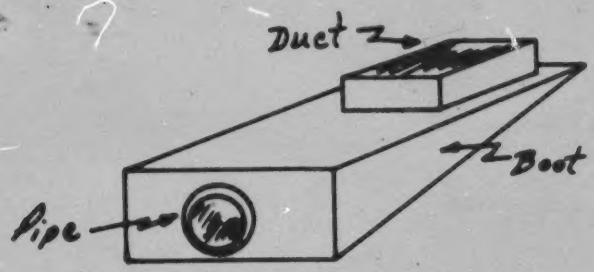
19. A cylindrical tank is needed to hold 500 gallons of lubricating oil. The base of the tank cannot have a diameter of more than 6 feet. What is the shortest the tank can be?

20. How many 1" pipes are needed to carry as much water as a 2" pipe?

21. Two 3" pipes run together into one pipe. What should be the diameter of the large pipe to carry the flow from the two small pipes?

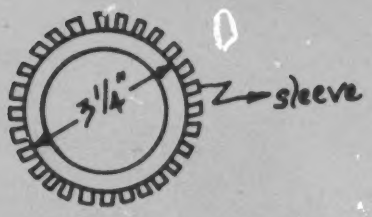
B. Problems without Solutions (continued)

22. A hot-air pipe 5" in diameter passes into a boot. A rectangular duct of the same capacity passes upward from the boot. If one measurement of the rectangular duct is 3", what is the other?



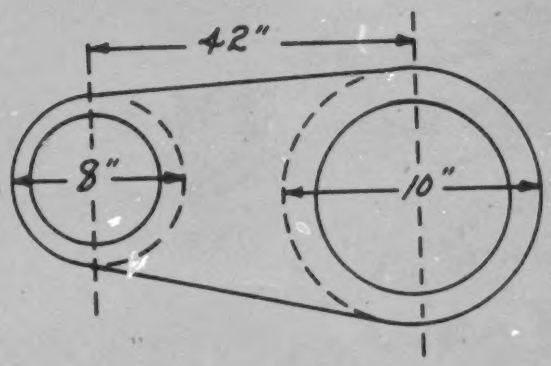
Complete Solutions to B Problems

4. Formula needed $C = \pi d$



Approximate length needed = πd
= (3.14)(3 1/4")
= (3.14)(3.25")
= 10.2 in

5. Formula needed $C = \pi d$



Total lengths = 2(42") + (1/2)π (8") + (1/2)π (10")
= 84" + (1/2)(3.14)(8") + (1/2)(3.14)(10")
= 84" + 12.56" + 15.70"
= 112.26 in or 112 1/4 in

6. Formula needed $C = \pi d$

C = 320 cm
320 cm = π d
320 cm = (3.14)d

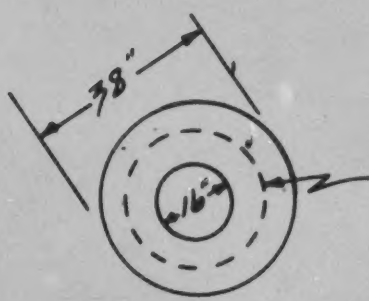
$$d = \frac{320 \text{ cm}}{3.14} = 102 \text{ cm}$$

$$d = \frac{102 \text{ cm}}{2.54 \text{ cm/in}} = 40.2 \text{ in}$$

7. Formula needed $C = \pi d$

The number of feet of hose = average circumference of a coil times the number of coils.

Average circumference = (3.14)(average diameter)
= (3.14)(27") = 85 in
Length of hose = (85")(26) = 2,210 in = 184 ft



Complete Solutions to B Problems (continued)

8. Formula needed $C = \pi d$

First need to convert 5 ft/sec to ft/min
(5 ft/~~sec~~)(60 ~~sec~~/min) = 300 ft/min

Figure belt speed in ft/min on 12" pulley :
$C_{12"}$ = (3.14)(12") = (3.14)(1') = 3.14 ft

Belt speed of 12" = (3.14 ft/~~rev~~)(50 ~~rev~~/min)
= 157 ft/min

Now find d:

$$\frac{12 \text{ in}}{d} = \frac{157 \text{ ~~ft/min~~}}{300 \text{ ~~ft/min~~}}$$

157d = 3,600 in

d = 23 in

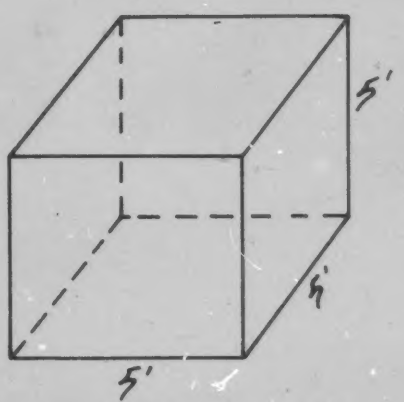
9. Formula needed $A = l w$

Area of material needed = 5 l w
= 5 (5')(5')
= 125 sq ft

Cost of material = ($2.89/~~sq ft~~)(125 ~~sq ft~~)
= $361.25

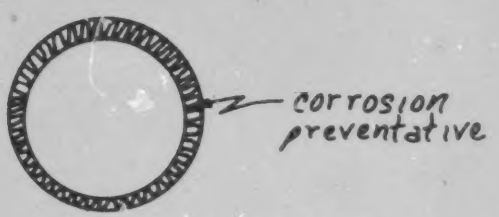
Cost of labor = (6 hr 45 min)($5.83/hr)
= (6.75 ~~hr~~)($5.83/~~hr~~)
= $39.35

Total cost = $361.25 + $39.35 = $400.60



10. Formulas needed: $C = \pi d$ and $A = l w$

Area of corrosion preventative needed:
C h = π d h
= (3.14)(8' 3")(6')
= (3.14)(8.25 ft)(6 ft)
= 155 sq ft



Gallons of corrosion preventative = $\frac{155 \text{ ~~sq ft~~}}{3 \text{ ~~sq ft~~/gal}}$

= 51.7 gal

Complete Solutions to B Problems (continued)

11. Formula needed $A = \pi r^2$

The tensile strength is directly proportional to the cross-sectional area.

r = radius of rod carrying 25,000 lbs

$$\frac{\pi (0.625 \text{ in})^2}{\pi r^2} = \frac{16{,}000 \text{ lbs/sq in}}{25{,}000 \text{ lbs/sq in}}$$

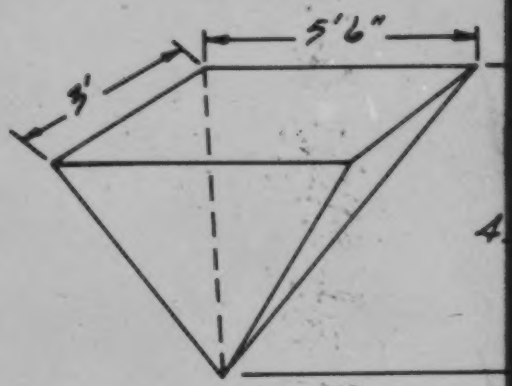
$$\frac{0.391 \text{ sq in}}{r^2} = \frac{16{,}000}{25{,}000}$$

$r^2 = 0.611$ sq in r = 0.782 in

$r = \sqrt{0.611 \text{ sq in}}$ diameter = 1.563 in

12. Formula needed $V = (1/3) l w h$

$V = (1/3)(3')(5' 6")(4.5')$
$= (1/3)(3 \text{ ft})(5.5 \text{ ft})(4.5 \text{ ft})$
$= 24.75$ cu ft



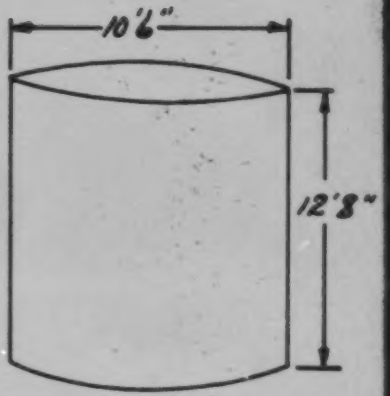
Convert volume to gallons

V = (24.75 ~~cu ft~~)(7.48 gal/~~cu ft~~)
= 185 gallons

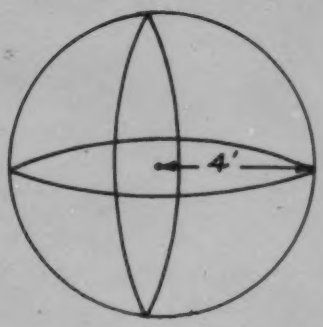
13. Formulas needed $C = \pi d$ and $A = lw$

Area of metal needed for top and bottom = $2(\pi)(5' 3")^2$
$= 2(3.14)(5.25 \text{ ft})^2$
$= 173$ sq ft

Area of metal needed for sides of tank
= (circumference)(height)
= $\pi d h$
= $(3.14)(10' 6")(12' 8")$
= $(3.14)(10.5 \text{ ft})(12.67 \text{ ft})$
= 418 sq ft
Total area = 173 sq ft + 418 sq ft = 591 sq ft
Cost = (591 ~~sq ft~~)($2.335/~~sq ft~~) = $1,379.99



Complete Solutions to B Problems (continued)



14. Formula needed $V = (4/3)\pi r^3$

$V = (4/3)\pi r^3 = (4/3)(3.14)(4\text{ ft})^3$
$= 268$ cu ft

V in gallons = (268 ~~cu ft~~)(7.48 gal/~~cu ft~~)
= 2,005 gal

Gallons left in tank = 2,005 gal - 110 gal = 1,895 gal

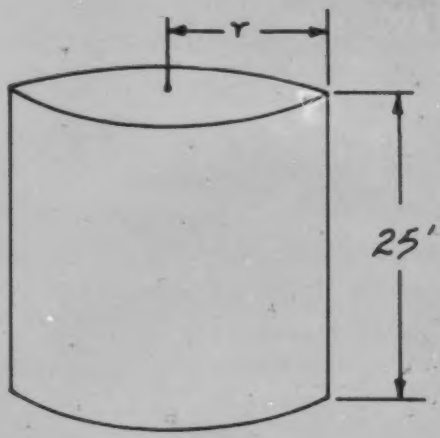
15. Formulas needed $V = \pi r^2 h$ and $V = (1/3)\pi r^2 h$

V of cylinder $= \pi r^2 h = (3.14)(3.5\text{ ft})^2(6.25\text{ ft})$
$= 240$ cu ft

V of cone $= (1/3)\pi r^2 h = (1/3)(3.14)(3.5\text{ ft})^2(3.083\text{ ft})$
$= 39.5$ cu ft

Total volume = 240 cu ft + 39.5 cu ft = 279.5 cu ft

16. Formula needed $C = 2\pi r$, $V = \pi r^2 h$



First find radius of tank
$C = 2\pi r$
$40\text{ ft} = 2(3.14)r$

$r = \frac{40\text{ ft}}{6.28} = 6.37$ ft

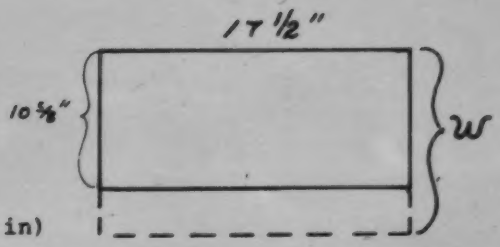
Find volume of tank
$V = \pi r^2 h$
$V = (3.14)(6.37\text{ ft})^2(25\text{ ft})$
$= 3{,}185$ cu ft
V = (3,185 ~~cu ft~~)(7.48 gal/~~cu ft~~)
= 23,824 gal

Complete Solutions to B Problems (continued)

17. Formula needed A = l w

w = new width

Old area = (10 5/8")(17 1/2")
= (10.625 in)(17.5 in)
= 186 sq in



New area = 186 sq in + (0.17)(186 sq in)
= 218 sq in

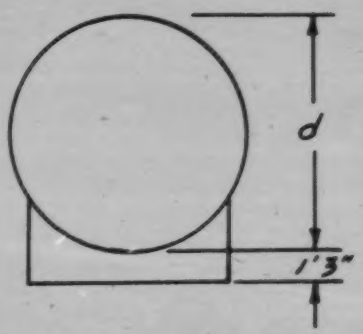
Calculating new width: A = l w

218 sq in = (17.5 in)(w)

$w = \frac{218 \text{ sq in}}{17.5 \text{ in}} = 12.5 \text{ in}$

18. Formula needed: $V = (4/3)\pi r^3$

$V = \frac{1{,}200 \text{ gal}}{7.48 \text{ gal/cu ft}} = 160 \text{ cu ft}$



$160 \text{ cu ft} = (4/3)\pi r^3$
$160 \text{ cu ft} = (4/3)(3.14)r^3$
$r^3 = 38.2 \text{ cu ft}$
$r = \sqrt[3]{38.2 \text{ cu ft}} = 3.36 \text{ ft}$
$d = 2(3.36 \text{ ft}) = 6.72 \text{ ft}$

Height of tank and stand = 6.72 ft + 1 ft 3 in
= 6.72 ft + 1.25 ft
= 7.97 ft

7.97 feet is less than 10 feet, so the tank will fit in the building.

19. Formula needed $V = \pi r^2 h$

$V = \frac{500 \text{ gal}}{7.48 \text{ gal/cu ft}} = 66.8 \text{ cu ft}$

$66.8 \text{ cu ft} = \pi r^2 h$, r = 3 ft
$66.8 \text{ cu ft} = (3.14)(3 \text{ ft})^2 h$

$h = \frac{66.8 \text{ cu ft}}{28.26 \text{ sq ft}} = 2.36 \text{ ft}$

Complete Solutions to B Problems (continued)

20. Formula needed $A = \pi r^2$

The total cross-sectional area of the 1" pipes must be equal to or greater than the cross-sectional area of the 2" pipe.

Area of 2" pipe = $\pi (1")^2 = (3.14)(1 \text{ in})^2 = 3.14$ sq in
Area of 1" pipe = $\pi (1/2")^2 = (3.14)(0.5 \text{ in})^2 = 0.785$ sq in

$$\text{Number of 1" pipes needed} = \frac{\text{cross-sectional area 2" pipe}}{\text{cross-sectional area 1" pipe}}$$

$$= \frac{3.14 \text{ sq in}}{0.785 \text{ sq in}} = 4$$

21. Formula needed $A = \pi r^2$

The cross-sectional area of the large pipe should have the same or greater cross-sectional area as the two 3" pipes.

Area of two 3" pipes = $2\pi (1\ 1/2")^2 = 2(3.14)(1.5 \text{ in})^2$
$= 14.13$ sq in

Area of large pipe: $14.13 \text{ sq in} = \pi r^2$
$14.13 \text{ sq in} = (3.14) r^2$

$$r^2 = \frac{14.13 \text{ sq in}}{3.14} = 4.5 \text{ sq in}$$

$$r = \sqrt{4.5 \text{ sq in}}$$
$$r = 2.12 \text{ in}$$

Diameter of large pipe = 2(2.12 in) = 4.24 in = 4 1/4 in

22. Formulas needed $A = \pi r^2$ and $A = l\ w$

The cross-sectional area of duct must be the same as the cross-sectional area of the pipe.

Area of pipe = $\pi r^2 = (3.14)(2.5 \text{ in})^2 = 19.6$ sq in
Area of duct: $19.6 \text{ sq in} = l\ w$
$19.6 \text{ sq in} = l(3 \text{ in})$

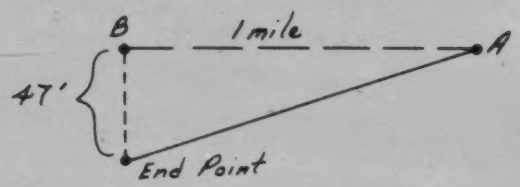
$$l = \frac{19.6 \text{ sq in}}{3 \text{ in}} = 6.5 \text{ in}$$

A. Problems with Solutions

1. Compasses often require declination adjustments in the field to correct for errors or to compensate for changes in declination. An angle of one degree is known to subtend a distance of 92 feet one mile from the vertex of the angle. The forester uses this relationship to correct for declination by prolonging a straight line from one known corner to another and then determining the amount of line error.

   Assume that a line one mile in length is run N 90° E from a point A and ends up 47 ft south of point B which is known to be due east of point A. If the error is due to the declination set off on the compass determine the correct declination if the off set was 20° 20' E when the above line was run.

   Solution:



$$\frac{47 \text{ ft}}{X} = \frac{92 \text{ ft}}{1^\circ} \qquad \text{(cross multiply)}$$

$$\left(\frac{47 \cancel{\text{ft}}}{92 \cancel{\text{ft}}}\right)(1^\circ) = X$$

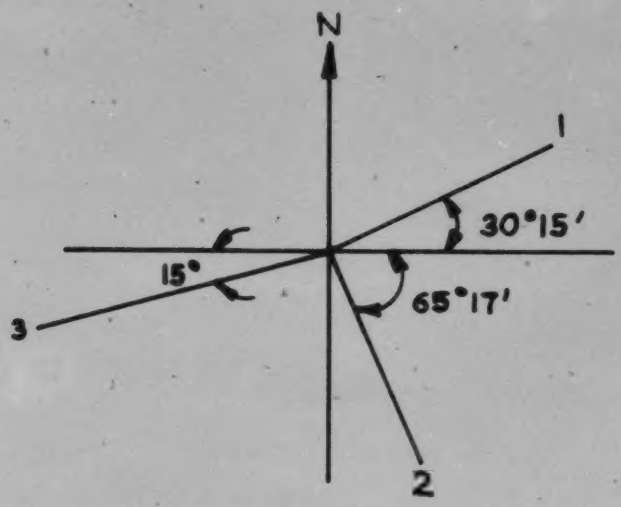
$$X = 0.51^\circ \qquad \text{(convert to minutes of arc)}$$

$$(0.51^\circ)\left(\frac{60'}{1^\circ}\right) = 30.7' \doteq 31'$$

original correction	20° 20' E
+ new correction	31' E
	20° 51' E

A. Problems with Solutions (continued)

2. Give the bearing and azimuth of lines 1, 2 and 3 in the sketch below.



Solution:

Note: The bearing is the smallest angle from the North-South line in a specified direction. The azimuth is measured by the clockwise rotation from the North pole.

Line 1

$90° - 30° 15' = 59° 45'$

Bearing = N 59° 45' E

Azimuth = $90° - 30° 15' = 59° 45'$

Line 2

$90° - 65° 17' = 24° 43'$

Bearing = S 24° 43' E

Azimuth = $90° + 65° 17' = 155° 17'$

Line 3

$90° - 15° = 75° 0'$

Bearing = S 75° 0' W

Azimuth = $270° - 15° = 255°$

A. Problems with Solutions (continued)

3. The interior angles of a traverse are as follows: A - 116° 15', B - 89° 45', C - 103° 30', D - 128° 45', E - 101° 45'. Point C is north of point B. Does the traverse close?

Solution:

Note: The traverse is closed provided the sum of the interior angles = (180°) times (n - 2) where n is the number of sides.

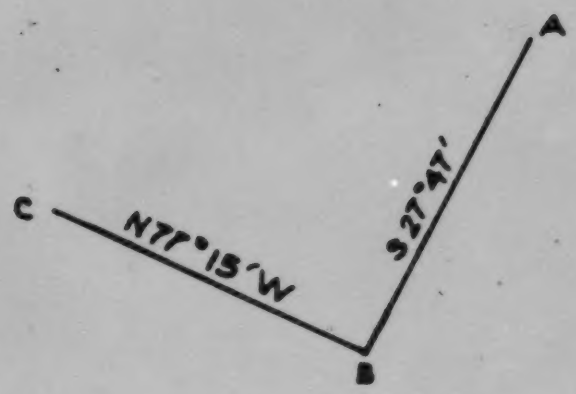
Sum of interior angles = 116° 15' + 89° 45' + 103° 30' + 128° 45' + 101° 45'
= 540°

(180°)(5 - 2) = 540° Therefore the traverse is closed.

B. Problems without Solutions

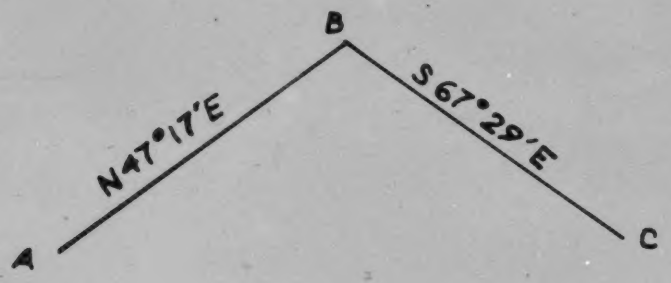
4. Divide the angle 38° 16' 17" into thirds. Round off your answer to the nearest second.

5. Given the bearings AB and BC determine the smaller angle between them.



B. Problems without Solutions (continued)

6. Determine the interior and exterior angle at B in the sketch below.



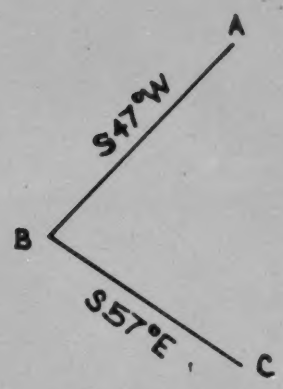
7. The magnetic bearing of a line AB is N 47° 17' E. The true bearing is N 31° 55' E. What is the magnetic declination at point A?

8. If the true bearing of a line is N 2° 15' E when the magnetic bearing reads N 17° 17' W, what is the magnetic declination?

9. If the bearing of a line from A to B is N 45° 00' W and from B to C N 10° 23' E, determine the interior angle at B.

B. Problems without Solutions (continued)

10. Given the two bearings AB and BC in the sketch below, determine a) the interior angle at B and b) the exterior angle at B.



11. The bearing of line AB is N 20° 15' E. The bearing of BC is S 61° 30' E. What is the deflection angle at B in running a traverse from A to B to C?

    Note: A deflection angle is the angle turned from a prolonged line through the station.

12. From A to B the bearing of a line is S 35° W. The deflection angle at B is 85° R. Determine the bearing of the line from B to C.

B. Problems without Solutions (continued)

13. From A to B the bearing of a line is N 46° 15' W. The deflection angle at B is 57° 48' Right. What is the bearing from B to C?

14. The magnetic bearing of a line on an old survey was recorded as N 37° 45' W when the declination was 5° 30' W. What magnetic bearing would be used to retrace the line if the current declination is 2° 45' E?

15. A line run from A to B has a magnetic bearing of N 39° 15' E. The declination in the area is 20° 15' E. At point B a deflection angle of 124° 32' is turned to point C. What is the magnetic bearing of line BC?

B. Problems without Solutions (continued)

16. Complete the missing entries in the table below.

	True Bearing	Declination	Magnetic Bearing	True Azimuth
a)	_____	19° W	_____	160° 45'
b)	S 86° 15' E	23° E	_____	_____

17. Convert the necessary quantities in order to complete the table below:

	True Bearing	Declination	Magnetic Bearing	True Azimuth
a)	S 59° 00' W	_____	S 40° 31' W	_____
b)	_____	20° 00'E	N 81° 15' W	_____

18. Complete the entries in the table.

	True Azimuth	True Bearing	Magnetic Bearing	Declination
a)	227° 30'	_____	_____	22° W
b)	_____	S 42° 45' W	S 20° 15' W	_____

19. Given the legal description,

SW $\frac{1}{2}$ of NE $\frac{1}{4}$ of SW $\frac{1}{4}$ of NE $\frac{1}{4}$ of Sec 30, T5S, R10E

Determine:

a) The area in square chains.
b) The distance around the parcel in chains.

Note: 1 section = 640 acres, 1 acre = 10 sq chains

B. Problems without Solutions (continued)

20. Determine the distance between a point A located at the NE section corner of Sec 23, T 11S, R 5W, WM and the SW section corner of Sec 32, T 11S, R 5W, WM.

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21			

Note: Sections in a township are numbered as above.

Complete Solutions to B Problems

4. Convert the angle into an equivalent form where the degrees and minutes are divisable by three:

$A = 38^\circ\ 16'\ 17'' = 36^\circ\ 136'\ 17'' = 36^\circ\ 135'\ 77''$

$\frac{A}{3} = 12^\circ\ 45'\ 25\ 2/3'' = 12^\circ\ 45'\ 26''$

5. Angle ABC = $77^\circ 15' + 27^\circ\ 47' = 104^\circ\ 62' = 105^\circ\ 02'$

6. Interior angle = $47^\circ\ 17' + 67^\circ\ 29' = 114^\circ\ 46'$

Exterior angle = $360^\circ - 114^\circ\ 46' = 245^\circ\ 14'$

7. The declination is to the west by an amount $47^\circ\ 17' - 31^\circ\ 55'$ or

$15^\circ\ 22'W$

8. Magnetic declination is to the east and equal to $2^\circ\ 15' + 17^\circ\ 17'$ or $19^\circ\ 32'$ E

9. Interior angle at B = $45^\circ\ 00' + 10^\circ\ 23' = 55^\circ\ 23'$

10. Interior angle = $47^\circ + 57^\circ = 104^\circ$

Exterior angle = $180^\circ - 104^\circ = 76^\circ$

11. Deflection angle = $180^\circ - (20^\circ\ 15' + 61^\circ\ 30')$
$= 180^\circ - 81^\circ\ 45'$
$= 98^\circ\ 15'$ R

12. True Azimuth of BC is True Azimuth of AB + 85° or
$180^\circ + 35^\circ + 85^\circ = 300^\circ$

Therefore the bearing from B to C is N 60° W.

13. Azimuth of AB = $360^\circ - 46^\circ\ 15' = 313^\circ\ 15'$

Azimuth of BC = $313^\circ\ 15' + 57^\circ\ 48' = 370^\circ\ 63' = 11^\circ\ 03'$

Bearing of BC = N $11^\circ\ 03'$ E

Complete Solutions to B Problems (continued)

14. True bearing of the line is 37° 45' plus the declination or N 43° 15'W. The magnetic bearing today would be 43° 15' + 2° 45' or N 46° 00'W.

15. $39° 15' + 124° 32' = 163° 47'$
$180° - 163° 47' = 16° 13'$
The bearing of BC is S 16° 13' E

16. (a) True bearing = 180° - True azimuth = S 19° 15' E
Magnetic bearing = True bearing - 19° = S 0° 15' E
(Note: subtract because declination is west)

(b) True azimuth = 180° - True bearing = 180° - 86° 15'
= 93° 45'
Magnetic bearing = 180° - (True bearing + declination)
= 180° - 109° 15'
= 70° 45' E

17. (a) Declination = True Bearing - Magnetic Bearing
= 59° - 40° 31'
= 18° 29' E
True azimuth = 180° + True bearing
= 180° + 59°
= 239°

(b) True bearing = Magnetic bearing - 20° 00'
= 81° 15' - 20° 00'
= N 61° 15' W
True azimuth = 360° - True bearing
= 360° 00' - 61° 15'
= 298° 45'

18. (a) True bearing = True azimuth - 180°
= 227° 30' - 180°
= S 47° 30' W
Magnetic bearing = True bearing + declination
= 47° 30' + 22°
= S 69° 30' W

(b) Declination = True bearing - Magnetic bearing
= 42° 45' - 20° 15'
= 22° 30' E
True azimuth = 180° + True bearing
= 180° + 42° 45'
= 222° 45'

Complete Solutions to B Problems (continued)

19. SW $\frac{1}{2}$ of NE $\frac{1}{4}$ of SW $\frac{1}{4}$ of NE $\frac{1}{4}$ of Sec 30

5	10	40	160	640	Acres
50	100	400	1,600	6,400	Sq chains

Area is rectangular, 5 chains by 10 chains
therefore:

(a) Area = 50 square chains

(b) Perimeter = 2(5 + 10) chains = 30 chains

20. By the Pythagorean Theorem, $D^2 = a^2 + b^2$ where a and b are the legs of a right triangle and are equal to 3 miles and 4 miles, respectively.

$$D = \sqrt{(3 \text{ miles})^2 + (4 \text{ miles})^2}$$

$$D = \sqrt{25 \text{ sq miles}}$$

$$D = 5 \text{ miles}$$

A. Problems with Solutions

1. Given the displacement of a 6-250 Chevrolet as 250 cu inches and the bore as 3.875". Find the stroke of the engine.

   Definitions: 6-250 engine: 6 cylinder, 250 cu in displacement

   Solution:

$$\text{Stroke of engine} = \frac{\frac{250 \text{ cu in}}{6 \text{ cylinders}}}{(3.875)^2 (0.7854)}$$

$$= \frac{41.667 \text{ cu in/cylinders}}{11.793 \text{ sq in/cylinders}}$$

$$= 3.53 \text{ in}$$

2. The PSI available from the power steering pump of a 1970 Chevrolet is 1450 PSI. If the pressure is acting on a 1 5/16" diameter piston, what maximum force is possible for control of the car?

   Solution:

$$\text{Force} = (1\ 5/16")^2 (0.7854)(1{,}450 \text{ lbs/sq in})$$

$$= (1.72266 \text{ ~~sq in~~})(0.7854)(1{,}450 \text{ lbs/~~sq in~~})$$

$$= 1{,}961.8 \text{ lbs}$$

3. If a power assist unit on a power brake applies a force of 801.32 lbs and the cylinder bore is 7/8", what pressure is developed in the braking system?

   Solution:

$$\text{Pressure} = \frac{801.32 \text{ lbs}}{(7/8")^2 (0.7854)} = \frac{801.32 \text{ lbs}}{(0.7656 \text{ sq in})(0.7854)}$$

$$= 1{,}332.6 \text{ lbs/sq in}$$

B. Problems without Solutions

4. The oil pressure on an engine is 40 PSI. If a connecting rod bearing is 1 1/8" wide and the journal is 1.998" with a standard clearance of 0.002", what force is applied against the bearing by the oil?

5. What force is applied against the crankshaft if an engine has a pressure of 320 lbs and a bore of 3.75"?

6. The air vents, etc., on a given vehicle are controlled by vacuum diaphragms. If the manifold vacuum is at 18" and the diaphragms are 1 5/8" diameter, what force is available for moving linkages? (Consider 30" as atmospheric pressure.)

7. The center disc on a master cylinder assist unit is 6 3/8" diameter and the vacuum maximum in the reserve tank is 24". What assist force may be expected in a panic stop? (Let 30" = atmospheric pressure, or 14.7 lbs.)

8. A car's weight is 3780 lbs. If 3/5 of the weight is on the front tires and the tire pressure is 24 lbs front and 28 lbs rear, how many square inches of tire are touching the ground in front? in the rear? Total?

B. Problems without Solutions (continued)

9. The bore of a 1971 Volkswagen is 3.37" and the stroke is 2.717". What is the displacement of one piston? What is the displacement of the engine?

10. A 1967 Chevrolet 6-230 has a bore of 3.895" and a stroke of 3.25". What would the increase in displacement be if it were bored to 0.020" oversize?
Definitions: 6-230: 6 cylinders and 230 cu in displacement

11. If aluminum expands lineally at the rate of 1/4" per foot, how much will the skirt of a piston expand if the bore is 3 1/2"?

12. An automobile has a master cylinder bore of 1 1/8" and a front cylinder bore of 2 15/16". The brake pedal has a lever advantage of 13:1. If a force of 20 lbs is applied to the pedal, what will be the force on the front brake lining?

B. Problems without Solutions (continued)

13. A 1971 Chevrolet has a master cylinder bore of 1 1/8", a front cylinder bore of 2 15/16", and a rear cylinder bore of 1". If a force of 100 lbs was put on the master cylinder, what total force would there be on all slave cylinders?

14. On a car which has a hydraulically operated clutch, the mechanical advantage at the throwout lever is 12 : 1, the pressure plate has a force of 316 lbs, and the master cylinder has a 7/8" bore. What must be the bore of the slave cylinder if the driver applies a force of 15.93 lbs to release the clutch?

15. A 1969 Plymouth has a bore of 3.40", a stroke of 3.125", a compression ratio of 7.5. If the engine is bored to 0.030" oversize, what would then be the compression ratio?

B. Problems without Solutions (continued)

16. The PSI available from the power steering pump of a 1970 Chevrolet is 1450. If the bore of the power cylinder is 1.5", what thickness of 45,000 lb tensile steel is necessary for a safety ratio(bursting).

17. A 1973 Pinto 2 liter has a radiator core which measures 15" x 18" and a fan blade 14 3/4" long with a 3 1/2" center relief at the hub. If (because of faulty mounts on the engine) the fan blade contacted and flattened the radiator fins shutting off the flow of air, what percentage of cooling would be lost?

18. A 1969 Plymouth has a bore of 3.40 inches, a stroke of 3.125", and a compression ratio of 8.5. What is the volume of the firechamber at TDC?
Definitions: TDC: top dead center

Complete Solutions to B Problems

4. Force on bearing = (π) (diameter of bearing) (width of bearing) (PSI)

Force = (π) (2.002 in) (1.125 in) (40 lbs/sq in)

= (3.1416) (2.25225 ~~sq in~~) (40 lbs/~~sq in~~)

= 283.03 lbs

5. Force = $(\text{Bore})^2$ (0.7854) (PSI)

= $(3.75 \text{ in})^2$ (0.7854) (320 lbs/sq in)

= (14.0625 ~~sq in~~) (0.7854) (320 lbs/~~sq in~~)

= 3,534.29 lbs

6. Force available = $\left(\frac{18 \text{ ~~in~~}}{30 \text{ ~~in~~}}\right)$ $(1.625 \text{ in})^2$ (0.7854) (14.7 lbs/sq in)

= (0.6) (2.640625 ~~sq in~~) (0.7854) (14.7 lbs/~~sq in~~)

= 18.29 lbs

7. Reserve force = $\left(\frac{24 \text{ ~~in~~}}{30 \text{ ~~in~~}}\right)$ $(6.375 \text{ in})^2$ (0.7854) (14.7 lbs/sq in)

= (0.8) (40.6406 ~~sq in~~) (0.7854) (14.7 lbs/~~sq in~~)

= 375.37 lbs

8. Ground contact on both front tires:

$\frac{(3{,}780 \text{ ~~lbs~~}) (3/5)}{24 \text{ ~~lbs~~/sq in}}$ = 94.5 sq in or 47.25 sq in each tire

Ground contact on both back tires:

$\frac{(3{,}780 \text{ ~~lbs~~}) (2/5)}{28 \text{ ~~lbs~~/sq in}}$ = 54 sq in or 27 sq in each tire

Total = 94.5 sq in + 54 sq in = 148.5 sq in

Complete Solutions to B Problems (continued)

9. Displacement of one piston = $(0.7854)(3.37 \text{ in})^2(2.717 \text{ in})$

$= 24.235 \text{ cu in}$

Displacement of engine = $(4 \text{ ~~cylinders~~})(24.235 \text{ cu in/~~cylinder~~})$

$= 96.94 \text{ cu in}$

10. Increase in displacement:

$6\left[(3.895" + 0.02")^2(0.7854)(3.25")\right] - 230 \text{ cu in} =$

$6\left[(15.327 \text{ sq in})(0.7854)(3.25 \text{ in})\right] - 230 \text{ cu in} =$

$234.738 \text{ cu in} - 230 \text{ cu in} = 4.738 \text{ cu in}$

11. Radial expansion = $\dfrac{(3.5 \text{ in})(\pi)(1/4 \text{ ~~in~~})}{(12 \text{ ~~in~~})(\pi)} = 0.073 \text{ in}$

12. Force on each front brake lining:

$$\left[\frac{(13/1)(20 \text{ lbs})}{(1.125 \text{ in})^2}\right](2.9375 \text{ in})^2 = \left(\frac{260 \text{ lbs}}{1.2656 \text{ ~~sq in~~}}\right)(8.629 \text{ ~~sq in~~})$$

$= 1{,}772.69 \text{ lbs}$

or

$$\frac{260 \text{ lbs}}{x} = \frac{(1.125 \text{ in})^2}{(2.9375 \text{ in})^2}$$

$$x = \frac{(8.629 \text{ ~~sq in~~})(260 \text{ lbs})}{1.2656 \text{ ~~sq in~~}}$$

$x = 1{,}772.69 \text{ lbs}$

13. Total force on all slave cylinders:

$$\left[\frac{100 \text{ lbs}}{(1.125 \text{ in})^2(0.7854)}\right](2)\left[(2.9375 \text{ in})^2(0.7854)\right] + 2\left[\frac{(100 \text{ lbs})(1 \text{ in}^2)(0.7854)}{(1.125 \text{ in})^4(0.7854)}\right] =$$

$$\left[\frac{100 \text{ lbs}}{(1.125 \text{ in})^2}\right](2)\left[(2.9375 \text{ in})^2 + 1\right] = (79.012 \text{ lbs/~~sq in~~})(19.2578 \text{ ~~sq in~~})$$

$= 1{,}521 \text{ lbs}$

Complete Solutions to B Problems (continued)

14. Bore of slave cylinder = B

$$316 \text{ lbs} = \left[\frac{(15.93 \text{ lbs})(12)}{(0.875 \text{ in})\ (0.7854)}\right] (B)^2 (0.7854)$$

$$316 \text{ lbs} = \frac{(191.16 \text{ lbs})(B)^2}{0.7656 \text{ sq in}}$$

$$316 \text{ lbs} = (249.68 \text{ lbs/sq in}) B^2$$

$$B^2 = \frac{316 \text{ lbs}}{249.68 \text{ lbs/sq in}}$$

$$B^2 = 1.2656 \text{ sq in}$$

$$B = 1.125 \text{ in}$$

15. Firing chamber volume $= \frac{(0.7854)(3.4 \text{ in})^2 (3.125 \text{ in})}{7.5}$

$$= \frac{28.3726 \text{ cu in}}{7.5} = 3.783 \text{ cu in}$$

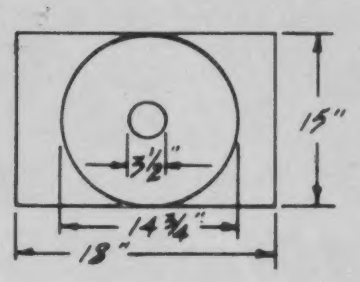
Compression ratio after boring 0.030" oversize:

$$\frac{3.783 \text{ cu in} + (0.7854)(3.43 \text{ in})^2 (3.125 \text{ in})}{3.783 \text{ cu in}} = \frac{32.658 \text{ cu in}}{3.783 \text{ cu in}} = 8.63$$

16. In one inch of cylinder length, the force against any side would be $[(1450)(1.5)]$ lbs. The cylinder must hold $[(2175)(5)]$ lbs. The cross-sectional area of the one inch length must then be $\frac{10,875}{45,000}$ of one square inch. This is 0.2414" thick and includes two sides. The thickness for one side would be $\frac{0.2414"}{2}$ or 0.1207 in.

17. Cooling surface left = $(15 \text{ in})(18 \text{ in}) - (0.7854)\left[(14.75 \text{ in})^2 - (3.5 \text{in})^2\right]$

= 270 sq in - 161.25 sq in = 108.75 sq in



$$\text{Cooling lost} = \frac{161.25 \text{ sq in lost}}{270 \text{ sq in total}}$$

= 0.597 = 59.7%

Complete Solutions to B Problems (continued)

18. FC = firing chamber volume

$$FC = \frac{(0.7854)(3.4\text{ in})^2(3.125\text{ in}) + FC}{8.5}$$

$$FC - \frac{FC}{8.5} = \frac{(0.7854)(11.56\text{ sq in})(3.125\text{ in})}{8.5}$$

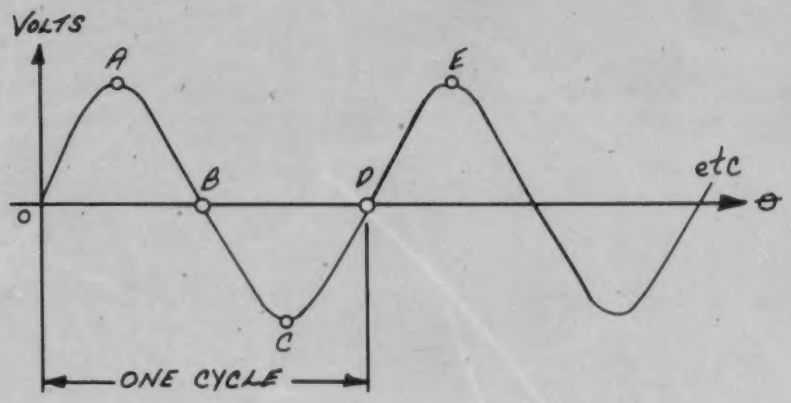
$$7.5FC = (0.7854)(36.125\text{ cu in})$$

$$FC = \frac{28.3726\text{ cu in}}{7.5}$$

$$FC = 3.783\text{ cu in}$$

A. Problems with solutions

1. The units of frequency (Hertz) actually mean cycles per second. One cycle represents a variation in alternating voltage (or current) through 360° of angular rotation. Given the sinusoidal wave as illustrated:



What is the angular position, θ, of the wave in degrees and radians at:

(a) Point A (b) Point B (c) Point C (d) Point D
(e) Point E

Solution:

(a) 90° or 1.571 ($\pi/2$) radians

(b) 180° or 3.143 (π) radians

(c) 270° or 4.712 ($3\pi/2$) radians

(d) 360° or 6.283 (2π) radians

(e) 450° or 7.854 ($5\pi/2$) radians

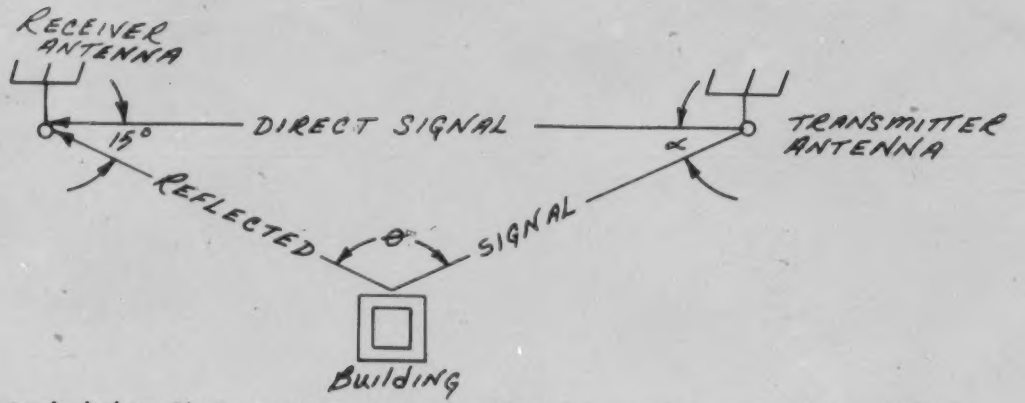
B. Problems without solutions.

2. The Clarostat type 628A miniature helical potentiometer (helipot) requires 10 full turns to vary its resistance from zero to its full- scale value.

   a. For the 0 - 100 K OHM unit, determine, the number of OHMs per degree and OHMs per minute of angular rotation of the shaft.

   b. If the shaft were rotated 1 3/4 turns, what change in resistance would result?

3.



A TV technician finds a strong ghost picture superimposed on the direct picture of a customer's TV set. By measurement with an "S" meter with a directional antenna he determines that the ghost is originating from a tall building as indicated in the sketch. This building is equidistant from the transmitter and the receiver.

a) What is the angle of reflection, θ, from the building?

B. Problems without solutions.

4. A two-pole alternating current generator has a rotor which is 36" in diameter and which is generating 60 Hertz power. The rotor makes one revolution per cycle of output woltage.

   a) What is the rotor speed in RPM?

   b) How far in feet would a point in the perimeter of the rotor move in one second?

   c) Express the velocity of this point in miles per hour.

Hertz = frequency = cycles per second

Complete solutions to B problems.

2. Determine the total rotation in degrees and minutes

(10 turns)(360 degrees) = 3600 Degree rotation

(360 ~~Degrees~~) (60 min/~~degree~~) = 216,000 minutes

a) $\frac{100{,}000 \text{ OHMs}}{3600 \text{ Degree}} = 27.78 \frac{\text{OHMs}}{\text{degree rotation}}$

$\frac{100{,}000 \text{ OHMs}}{216{,}000 \text{ minutes}} = 0.463 \frac{\text{OHMs}}{\text{minute}}$

b) 1 3/4 turns = 360 degrees + 270 degrees = 630 degrees

R = (630 ~~degrees~~) (27.78OHMs/~~degree~~) = 17,501 OHMS

= 17.5 OHMs

3. $\alpha + \theta + 15^\circ = 180^\circ$

Since the building is equidistant from transmitter and receiver, must also equal 15°.

So $\theta + 15^\circ + 15^\circ = 180^\circ$

$= 180^\circ - 30^\circ = 150^\circ$

4. A. Rotor speed S = (60 revolutions/~~second~~)(60~~seconds~~/minute) =3600 RPM.

B. Perimeter = πd = (π) (36 in) = (3.14)(36inches) = 113.1 inches

Distance traveled in one second = (60 revolutions/sec)(113.1 in/~~rev~~)

= 6,786 in/sec

= 565.5 ft/sec

C. Velocity = (565.5 ~~ft~~/~~sec~~)(3,600 ~~sec~~/hr)(1 mi/5,280 ~~ft~~) = 385.6 mi/hr

A. Problems with solutions.

1. The degree of steepness in a roof is indicated in terms of pitch. Pitch being equal to the rise divided by the span. However, in doing calculations one needs to know the inclination angle that the rafter makes with the ceiling joist. Convert the following standard pitches to an angle in degree:

$$\frac{2}{12}, \frac{4}{12}, \frac{6}{12}, \frac{7}{12}$$

Slope is used to express the amount of rise or fall in road beds, drain field layouts, drainage areas, road side embankments, etc. Slope is equal to rise divided by run or the tangent of the inclination angle expressed in percent.

Solution:

$\tan\theta = \frac{2}{12}$

$= 1/6$

$= 0.17$

$\theta = 9.46^\circ$

$\approx 9\ 1/2$

$\tan\theta = \frac{4}{12}$

$= 1/3$

$= 0.33$

$\theta = 18.43^\circ$

$\approx 18\ 1/2$

$\tan\theta = 6/12$

$= 1/2$

$= 0.5$

$\theta = 26.57^\circ$

$\approx 26\ 1/2$

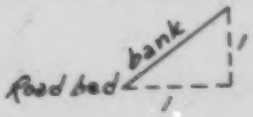
$\tan\theta = 7/12$

$= 0.58$

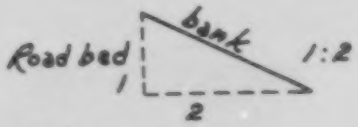
$\theta = 30.26^\circ$

≈ 30

2. Roadside embankments are expressed in terms of ratios. For example:



$= 1:1$



Express the following ratios as a % slope and an angle:

1:1 1:2 3:2 4:2 2:4

Solution : 1:1 $\tan\theta = 1/1 = 1$

$\theta = 45^\circ$

% slope $= (100)(1) = 100\%$

1:2 $\tan\theta = 1/2 = 0.5$

$\theta = 26.57^\circ$

% slope $= (100)(.5) = 50\%$

A. Problems with solutions.

2. continued.

3:2 $\tan\theta = 3/2 = 1.50$ $\quad\theta = 56.309^\circ$ $\quad$ % slope = (100)(150) = 150%

4:2 $\tan\theta = 4/2 = 2$ $\quad\theta = 63.43^\circ$ $\quad$ % slope = (100)(2) = 200%

2:4 $\tan\theta = 2/4 = 0.5$ $\quad\theta = 26.57^\circ$ $\quad$ % slope = (100)(0.5) = 50%

3. In freeway construction the maximum grade (slope) is 8%. How many degrees is this?

Solution: $8/10 = .08$

$\tan\theta = .08$

$\theta = 4.57^\circ$

4. Convert the following to either slope of degrees:

2% = _____deg. $\quad$ 15 = _____ slope

45% = _____deg. $\quad$ 45 = _____ slope

100% = _____deg. $\quad$ 90 = _____ slope

3.8% = _____deg. $\quad$ 2.5 = _____ slope

Solution:

2% = 2/100 = 0.02: $\tan\theta = 0.02$ $\theta = 1.146^\circ$

45% = 45/100 = 0.45; $\tan\theta = 0.45$ $\theta = 24.228^\circ$

100% = 100/100 = 1.00: $\tan\theta = 1.00$ $\theta = 45.00^\circ$

3.8% = 3.8/100 = 0.038: $\tan\theta = 0.038$ $\theta = 2.176^\circ$

A. Problems with solutions.

4 continued.

15° tan 15° = 0.268 ; (0.268)(100) = 26.8% slope

45° tan 45° = 1.000 ; (1000)(100) = 100.00% slope

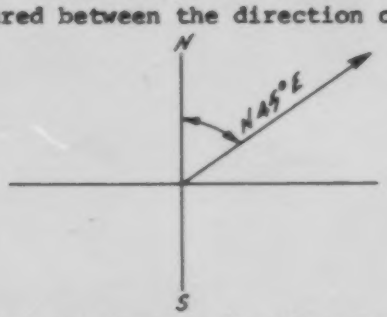
90° tan 90° does not exist because division by 0 is not permissible

2.5° tan 2.5° = 0.0437 : (0.0437)(100) = 4.370% slope

B. Problems without solutions.

5. Drainfields for septic systems connot be installed on a hillside with positive angle

6. In surveying the term bearing is used to talk about direction. The bearing is an acute angle measured between the direction of travel and the North-South meridian.



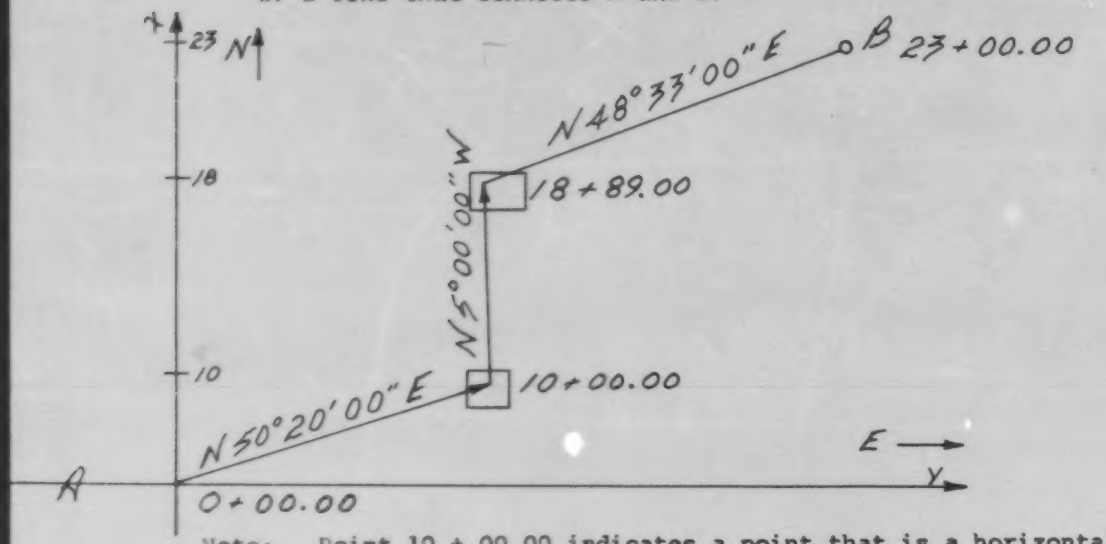
However, it is sometimes desirable to express the direction of travel as a positive angle made with respect to the positive x axis.

Express the following bearings as a positive angle made with respect to the positive x axis:

a) N 30 20' E _____ positive angle
b) N 22 45' W _____
c) N 0 36' E _____
d) S 43 20' E _____
e) S 55 45' W _____

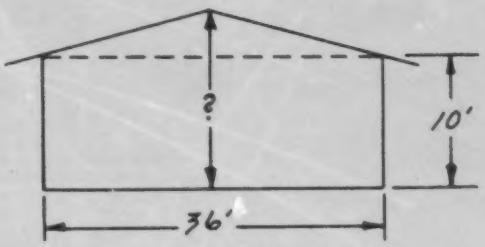
B. Problems without solutions.

7. What is the distance between points A and B? Also what is the bearing of a line that connects A and B?



Note: Point 10 + 00.00 indicates a point that is a horizontal distance of 1,000 feet from a reference point designated 0 + 00.00. 18 + 89.00 will be 1,889 feet, etc. Also note that B is actually lower than A.

B. Problems without solutions.



8. When looking at the gable end of a house it is rather easy to make the indicated measurements. However, the gable height requires a ladder. Knowing that this roof has a 4:12 pitch, compute the gable height, and then the surface area of the whole side.

9. The siding used on this house is 1" x 4" x 12" T&G (tongue and groove). However, each board only covers 3 1/4 inches. Compute the number of board feet that must be ordered in order to cover the entire end. 144 cu in = 1 board foot.

Complete solutions to B problems.

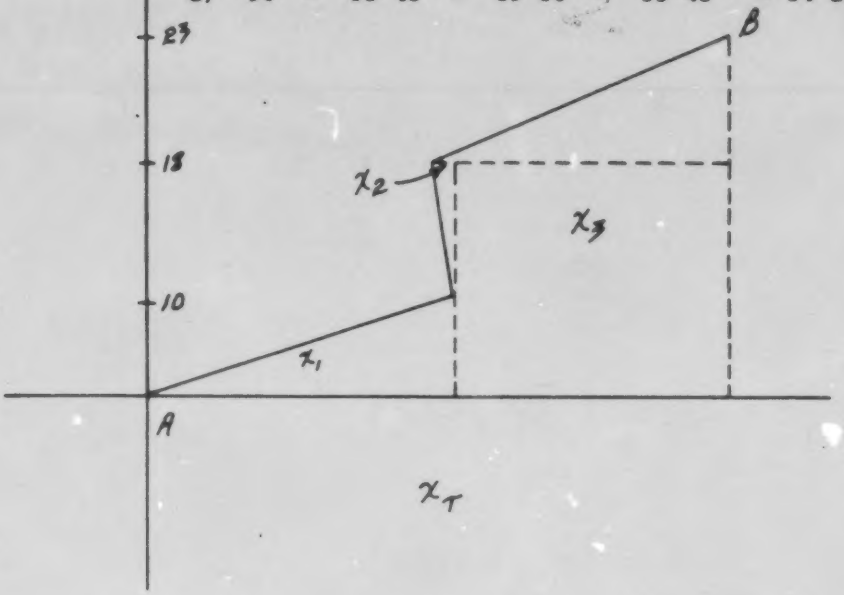
5. $12\% = 12/100 = 0.12$

$\tan \theta = 0.12$

$\theta = 6.84^\circ$

$\approx 7^\circ$

6. a) $90^\circ - 30^\circ 20' = 89^\circ 60' - 30^\circ 20' = 59^\circ 40'$
   b) $90^\circ - 22^\circ 45' = 89^\circ 60' - 22^\circ 45' = 67^\circ 15'$
   c) $90^\circ - 0^\circ 36' = 89^\circ 60' - 0^\circ 36' = 89^\circ 24'$
   d) $90^\circ - 43^\circ 20' = 89^\circ 60' - 43^\circ 20' = 46^\circ 40'$
   e) $90^\circ - 55^\circ 45' = 89^\circ 60' - 55^\circ 45' = 34^\circ 15'$



You need to find x so that you can find the distance from A to B. By dividing the space between the points into right triangles, you may find x_1, x_2, and x_3, and from these x_T. Because the third point doubles back on the distance x_T, you will have to subtract x_2 from the base of the triangle formed between the third point and point B.

To find x_1, use the tangent function.

$$x = \frac{10 \text{ feet}}{\tan 39^\circ 40'}$$

$= 12.17$ feet

Complete solutions to B problems.

7. continued.

To find x_2, again use the tangent function.

$x = (\tan 15^\circ)(8 \text{ feet})$

$= 0.70 \text{ feet}$

again, use the tangent function to find the base of the triangle formed between the third point and point B.

$$\text{Base} = \frac{5 \text{ feet}}{\tan 41^\circ 27'}$$

$= 5.7 \text{ feet}$

To get x_3, subtract x from the base of the triangle formed between the third point and point B.

$\text{Base} - x_2 = 5.7 \text{ feet} - 0.70 \text{ feet}$

$= 5 \text{ feet}$

$x_T = x_1 + x_3$

$= 12.17 \text{ feet} + 50 \text{ feet}$

$= 17.17 \text{ feet}$

Now that we know the two sides of the right triangle which has the line AB as it's hypotenuse, we can determine it's length, since the square root of the sum of the squared sides is equal to the hypotenuse.

$$AB = \sqrt{(x)^2 + (23)^2}$$

$$= \sqrt{(17.17 \text{ ft})^2 + (23 \text{ ft})^2}$$

$$= \sqrt{294.81 \text{ ft} + 529 \text{ ft}}$$

$$= \sqrt{823.81 \text{ ft}}$$

$= 28.7 \text{ ft}$

We can find the angles between AB and x by using either the sine or cosine function. We shall use the sine function.

$$\text{sine} = \frac{\text{opposite side}}{\text{hypotenuse}}$$

$$= \frac{23 \text{ ft}}{28.7 \text{ ft}}$$

Complete solutions to B problems.

7. continued.

= 0.80 ft

= 53.26° = 53°15' 26"

Since bearing is measured from north, we need to subtract this from 90° (or 89°60')

89°60' - 53°15' 26" = N 36° 44' 34" E

8. Taking one of the triangles of the gable area, we need to find it's height. We know that it's base is one half of the whole side, or 18ft. The pitch is given as 4:12, which means that for every 12 feet of run, the rise is 4 feet. 18 feet is 1 1/2 times twelve, so the rise must be 1 1/2 times 4, or 6 feet. So the total gable height is 10 feet + 6 feet = 16 feet.

The surface area of the whole side is equal to the area of the rectangle plus the area of the two triangles.

Area = (36')(10') + (2)(1/2)(6')(18')

= 360 ft + 108 ft

= 468 ft

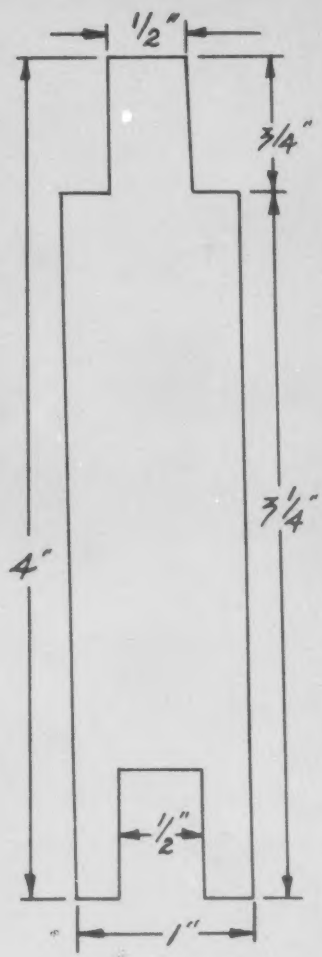
9. Each board has 468 cu. in.
(You can cut off the tongue and place it in the groove to solve for the board volume). There are 144 cubic inches in one board foot.

$$(468\ \cancel{\text{cu in}}/\ \text{board})(\ 1\ \text{bdft}/144\ \cancel{\text{cuin}}) = 3.25\ \frac{\text{bd ft}}{\text{board}}$$

From the previous problem, the surface area of this end of the house is 468 sq ft, and since the surface area of one board is (3 1/4")(144') = 3.25 sq ft

$$\frac{468\ \cancel{\text{sq ft}}}{3.25\ \frac{\cancel{\text{sq ft}}}{\text{board}}} = 144\ \text{boards}$$

(144 boards)(3.25 bd ft/board) = 468 board feet

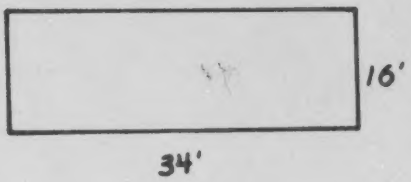


A. Problems with Complete Solutions

1. Find the area and perimeter of a shop floor 34 feet long and 16 feet wide.

Solution:

Sketch and label



A = LW

A = (34')(16') = 544 sq ft

P = 2L + 2W

P = 2(34') + 2(16') = 100 ft

2. Find the area and perimeter of a regular octagonal bar of steel when one side is 3/8" and the apothem is approximately 5/16".

Solution:

Def: a = apothem -- the perpendicular forms a right angle with side, distance from center of polygon to side.

Sketch and label

P = NS

P = 8(3/8 in)

P = 3 in

A = (1/2)aP

A = (1/2)(5/16 in)(3 in)

A = 0.469 sq in

A. Problems with Complete Solutions (continued)

3. The pattern for a drill press table is 4 5/8" in diameter. What is the circumference and area of the pattern?

Solution:

Sketch and label

$A = \pi r^2$

$A = (3.14)\left(\frac{37"}{16}\right)^2$

$A = 16.79$ sq in

$C = \pi D$

$C = (3.14)\left(\frac{37"}{8}\right)$

$C = 14.52$ in

B. Problems without Complete Solutions

4. A blue print is 1 1/2' wide and 2' long. How many can be printed from a roll of blue print paper 36" wide and 50 yards long?

Solution:

5. A triangular machine guard is made of wire mesh. If the base is 12 feet and the altitude is 5 feet, how many square feet of mesh are required?

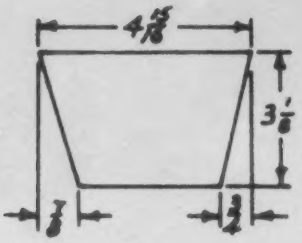
Solution:

B. Problems without Complete Solutions (continued)

6. The radius of a broken pulley is 8 1/4". What is the area and circumference of the pulley?

   Solution:

7. A fixture on a lathe looks like this. What is the area of the face?



   Solution:

8. A punch press blanks out sheet iron disks for bottoms of tin cans. The diameter of the bottom of the can is 6 1/4". What is the area of the bottom of the can?

   Solution:

B. Problems without Complete Solutions (continued)

9. How long must a bar 2" thick and 2.2" wide be to contain 55 cubic inches?

   Solution:

10. A 1/2 inch drill cuts a hole through a casting 4" thick. How much metal is removed?

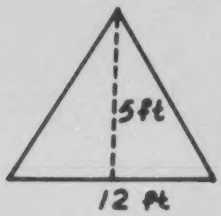
    Solution:

4. Change total goods to feet and divide by length of blue print, this will give number of blue prints on one side, double this number as width of paper will allow two blue prints side by side.

$$\text{Number of blue prints} = \frac{(50 \cancel{\text{yds}})(3 \cancel{\text{ft}}/\cancel{\text{yd}})(2 \text{ blueprints})}{2 \cancel{\text{ft}}}$$

$$= 150 \text{ blue prints}$$

5. Sketch and label

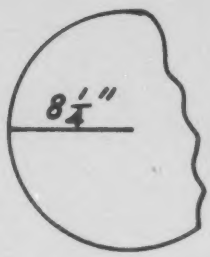


$A = (1/2)(bh)$

$A = (1/2)(12')(5')$

$A = 30 \text{ sq ft}$

6. Sketch and label



$A = \pi r^2$

$A = (3.14)(8.25")^2$

$A = 213.72 \text{ sq in}$

$C = \pi D = \pi(2r)$

$C = (3.14)(2)(8.25")$

$C = 51.81 \text{ in}$

7. Sketch and label

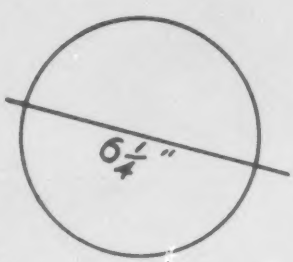
Trapezoid $A = (1/2)(a)(b + b')$

$A = (1/2)(3\ 1/8")(4\ 15/16 \text{ in} + 3\ 5/16 \text{ in})$

$A = (0.5)(3.125 \text{ in})(4.9375 \text{ in} + 3.3125 \text{ in})$

$A = 12.89 \text{ sq in}$

8. Sketch and label



$A = \pi r^2$

$A = (3.14)\left(\frac{25"}{8}\right)^2$

$A = 30.66 \text{ sq in}$

9. $V = LWH$

$55 \text{ cu in} = L(2")(2.2")$

$$\frac{55 \text{ cu in}}{4.4 \text{ sq in}} = L$$

$12.5 \text{ in} = L$

10. A cylinder's volume is given by: $V = \pi r^2 h$

$V = \pi(1/4")^2 (4")$

$V = (3.14)(0.25")^2 (4")$

$V = 0.785 \text{ cu in}$

A. Problems with Complete Solutions

1. How many degrees apart are the cutting faces on the side milling cutter?

Solution:

Count the teeth in the figure, this will divide circle(360°) into equal number of parts.

$$\text{Angle between teeth} = \frac{360^\circ}{15 \text{ teeth}}$$

$$= 24^\circ$$

2. A cam in the distributor of an automobile controls the firing of 6 cylinders. How many degrees between each contact of firing on the cam?

Solution:

There are 360 degrees in a full circle and we are dividing this into 6 equal parts.

$$\text{Angle} = \frac{360^\circ}{6} = 60^\circ$$

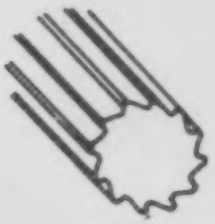
B. Problems without Complete Solutions

3. A cutter in a machine shop has 16 teeth. How many degrees between two teeth?

Solution:

B. Problems without Complete Solutions (continued)

4. How many degrees are between any two teeth of the reamer?



Solution:

5. What is the angle of drill in the following diagram?

Solution:

Complete Solutions to B problems

3. Number of degrees in a circle divided by the number of teeth.

$$\text{Angle between teeth} = \frac{360^\circ}{16 \text{ teeth}}$$

$$= 22^\circ\ 30'$$

4. Count teeth in reamer and divide number of degrees in circle by number of teeth in reamer.

$$\text{Angle between teeth} = \frac{360^\circ}{12 \text{ teeth}}$$

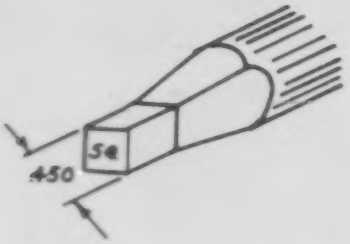
$$= 30^\circ$$

5. Face of drill has an angle of 59° with ℄, other face and ℄ would also be 59°, total angle then is 118°, by vertical angles, angle X = 118°.

   Def: Vertical Angles -- if two lines intersect, the opposite angles are equal.

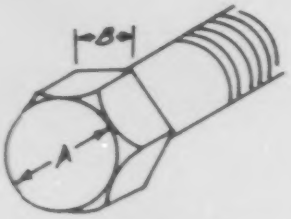
B. Problems without Complete Solutions

3. Find the sides of the following flat punch given, the diameter is 0.450".



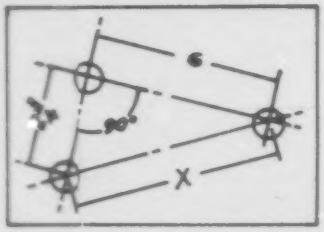
Solution:

4. If A = 7/8", what is the diameter of the stock needed for the head of the bolt?



Solution:

5. The following jig is being made for a drill press. How far is the distance (x) between centers?



Solution:

A. Problems with Complete Solutions

1. Find the diameter of the following square flat punch given, the sides are 1 5/16" in length.

Solution:

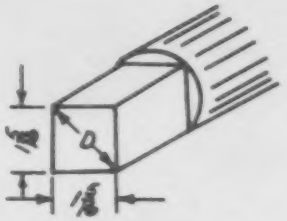
$D^2 = a^2 + b^2$ and $a = b$ in this case

$D = \sqrt{2(1\ 5/16\ in)^2}$

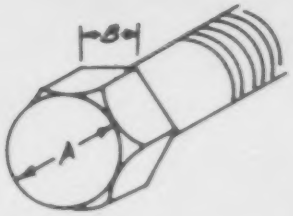
$D = \sqrt{2(1.3125\ in)^2}$

$D = \sqrt{3.4453\ sq\ in}$

$D = 1.856\ in$



2. If B = 5/8", what is the diameter of round stock needed to make the head of the bolt?



Solution:

Side opposite the 30° angle in a 30°- 60°- 90° angle triangle is 1/2 the hypotenuse. (use in reverse order)

Head of bolt is a Hexagon, thus 60°

B = 5/8"

(1/2)B = 5/16"

(1/2)Diameter = 2(5/16") = 5/8"

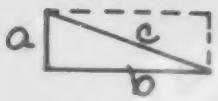
Diameter = 2(5/8") = 10/8" = 1 1/4 in

3. $c^2 = a^2 + b^2$ a = b in this case

$c^2 = 2a^2$

$(0.450 \text{ in})^2 = 2a^2$

$0.318 \text{ in} = a$



4. $a^2 + (7/16 \text{ in})^2 = (2a)^2$

$(0.4375 \text{ in})^2 = 3a^2$

$0.1914 \text{ sq in} = 3a^2$

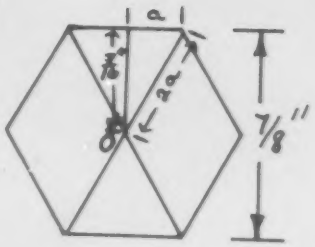
$0.0638 \text{ sq in} = a^2$

$0.2526 \text{ in} = a$

$0.5052 \text{ in} = 2a$

$d = 2(2a)$

$d = 1.0104 \text{ in}$



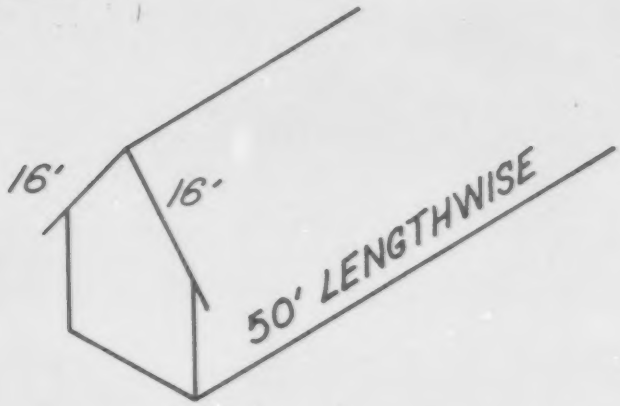
5. $x^2 = a^2 + b^2$

$x = \sqrt{(2\ 3/4 \text{ in})^2 + (6)^2}$

$x = 6.6 \text{ in}$

A. Problems with Solutions

1. Cannery picking boxes are stacked and covered with corrugated sheet metal to protect them from the weather. The stack dimensions are:



If a 16 ft length of corrugated sheet metal covers 23 inches lengthwise, how many sheets will cover this stack? (Count an extra sheet for any part of a sheet.)

Solution:

Length = (50 ~~ft~~)(12 in/~~ft~~) = 600 in

Sheets for one side = $\frac{600\ \text{~~in~~}}{23\ \text{~~in~~/sheet}}$ = 26.1 sheets

Total sheets needed = (27 sheets/~~side~~)(2 ~~sides~~) = 54 sheets

B. Problems without Solutions

2. Some of the Central Oregon mint growers have started using an irrigation system that has a traveling pipe that goes around the well. The traveling pipe is the radius of a huge circle that is to be watered. If Grower Turner has a traveling pipe that measures 1320 feet, how many acres are there in the circle that he is watering?

DEFINITIONS:

$\pi = 3.1416$

area of a circle $= \pi r^2$

1 acre = 43,560 sq ft

B. Problems without Solutions (continued)

2. (continued)

Level 2

3. Grower Thompson has a triangular field and wants to know the number of acres in this field. The three sides measure 620 ft, 786 ft, and 938 ft. How many acres in this triangle? (State your answer to the nearest thousandth.)

DEFINITIONS: If a, b, and c stand for three sides of a triangle and if s stands for one-half the sum of a, b, and c, then the area A of a triangle is given by the formula.

$s = 1/2\ (a+b+c)$, $A = \sqrt{s(s-a)(s-b)(s-c)}$. One acre = 43,560 sq ft.

Complete Solutions to B Problems

2. Area watered $= \dfrac{\pi r^2}{43{,}560 \text{ sq ft/acre}}$

$= \dfrac{(3.1416)(1{,}320 \text{ ft})^2}{43{,}560 \text{ sq ft/acre}}$

$= \dfrac{5{,}473{,}923.8 \text{ ~~sq ft~~}}{43{,}560 \text{ ~~sq ft~~/acre}}$

$= 125.66 \text{ acres}$

Level 2

3. $A = \sqrt{s(s-a)(s-b)(s-c)}$

$A = \sqrt{(1{,}172 \text{ ft})(1{,}172 \text{ ft} - 620 \text{ ft})(1{,}172 \text{ ft} - 786 \text{ ft})(1{,}172 \text{ ft} - 938 \text{ ft})}$

$A = \sqrt{(1{,}172 \text{ ft})(552 \text{ ft})(386 \text{ ft})(234 \text{ ft})}$

$A = \sqrt{58{,}434{,}569{,}856 \text{ ft}^4}$

$A = 241{,}732.43 \text{ sq ft}$

$\text{Acres} = \dfrac{241{,}732.43 \text{ ~~sq ft~~}}{43{,}560 \text{ ~~sq ft~~/acre}} = 5.55 \text{ acres}$

A. Problems with solutions.

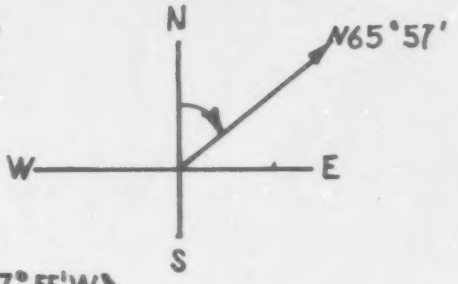
1. Definition: True bearings are acute angles which a line makes with the North-South meridiam. The quadrant as well as the angle must be specified.

   Definition: Azimuth is the angle that a line makes with the North-South meridian and is measured from 0 to 360 in a clockwise direction.

   convert the following bearings to azimuths:

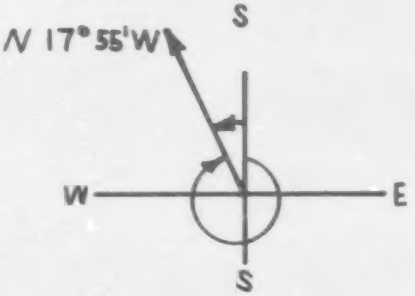
   a) N65° 37'E c) S83° 14'E

   b) N17° 55'W d) S33° 17' 5" W

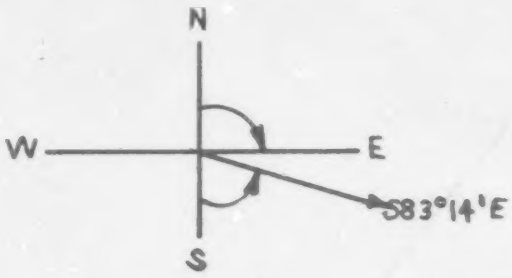


Solution:

a) Since we are in the NE quadrant the azimuth is 65°37'.

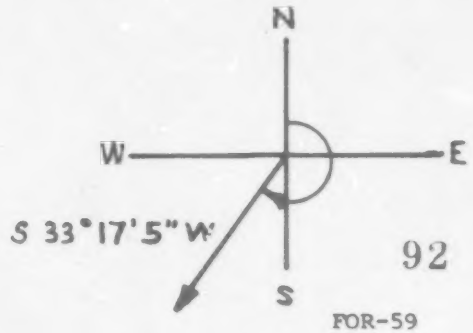


b) Since we are in the NW quadrant
   azimuth = 360° - 17° 55'
   = 359°60' - 17°55'
   = 342°05'



c) Since we are in the SE quadrant
   azimuth = 180° - 83°14'
   = 179°60' - 83°14'
   = 96°46'

d) Since we are in the SW quadrant
   azimuth = 180° + 33°17' 5"
   = 213° 17' 5"



B. Problems without solutions.

2. Convert the following azimuths to bearings

a) 232° 19' b) 21° 58' c) 145° 35' d) 304° 24' 03"

3. Definition: A <u>traverse</u> is a series of distances and angles (or distances and bearings or azimuths) connecting successive instrument points.

Formula: The sum of the interior angles of a polygon is $(n - 2)(180^{\circ})$ where n is the number of sides of the polygon.

The boundary line of a piece of property forms what is called a <u>closed traverse</u>. A traditional way to test the accuracy of a closed traverse is to measure the interior angles turned at each point and then add the interior angles of the resulting polygon comparing the result to $(n - 2)(180^{\circ})$.

a) A survey party traversed a boundary of a proposed timber sale which contained five sides. The 5 interior angles formed were: 186° 35', 37° 51', 93°18', 68° 49', and 153° 27'. Determine the error, if any, in this traverse.

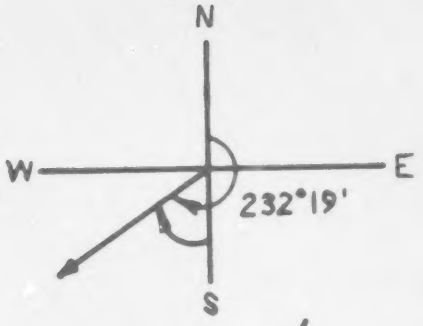
b) A closed traverse having six sides has interior angles of : 131° 30', 88°35', 129°11', 115° 10'. 118° 45', and 134° 29'. Determine the error, if any in this traverse.

Complete solutions to B problems.

2. Solution:

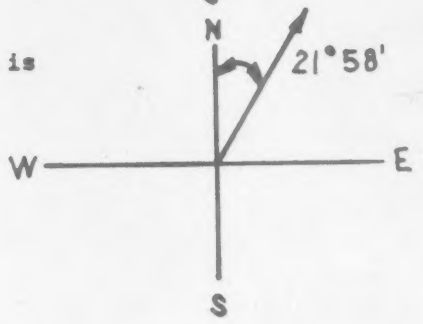
a) Since we are in the SW quadrant the bearing is
S(232° 19' - 180°) W =

S 52° 19'W

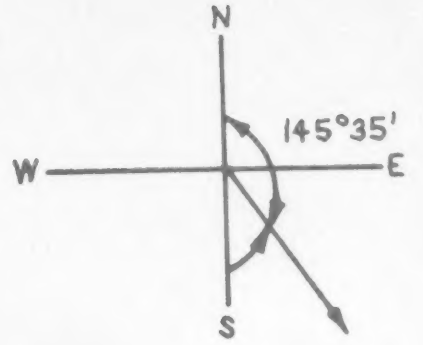


b) Since we are in the NE quadrant the bearing is

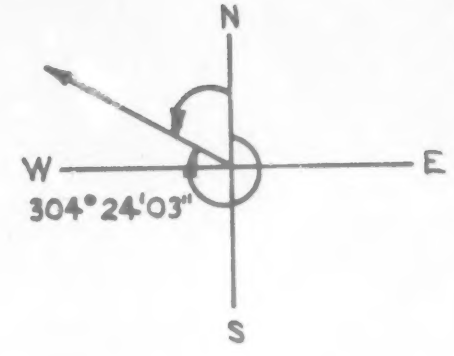
N 21° 58' E.



c) Since we are in the SE quadrant the bearing is
S(180°- 145° 35') E =
s(179° 60' - 145° 35') E =
S 34° 25' E



d) Since we are in the NW quadrant the bearing is
N(360°- 304° 24' 03") W
N (359° 59' 60" - 304° 24' 03")W
N 55° 35' 57"W



Complete solutions to B problems, continued.

3. Solutions:

a) $186^{\circ}35' + 37^{\circ}51' + 93^{\circ}18' + 68^{\circ}49' + 153^{\circ}27' = 537^{\circ}180'$ or 540°.

the expected sum is $(5-2)180^{\circ} = (3)\ (180^{\circ}) = 540^{\circ}$

b) $131^{\circ}\ 30' + 88^{\circ}35' + 129^{\circ}11' + 115^{\circ}\ 10' + 118^{\circ}45' + 134^{\circ}29' =$

$= 715^{\circ}\ 160'\ = 717^{\circ}40'$

the expected sum is $(6-2)\ 180^{\circ} = (4)\ (180)^{\circ} = 720^{\circ}$

thus the error is $720 - 717^{\circ}\ 40'\ = 2^{\circ}\ 20'$

GEOMETRY (similar triangles) Forestry
Level II

A. Problems with complete solutions

1. The scale of a vertical aerial photograph is determined by the focal length and the height from which the exposure was made. As can be seen in the diagram, there are several pairs of similar triangles so that the following proposition can be set up:

$\frac{F}{H} = \frac{P}{G} = \frac{1}{x}$ where $\frac{1}{x}$ is called the natural scale or representative fraction.

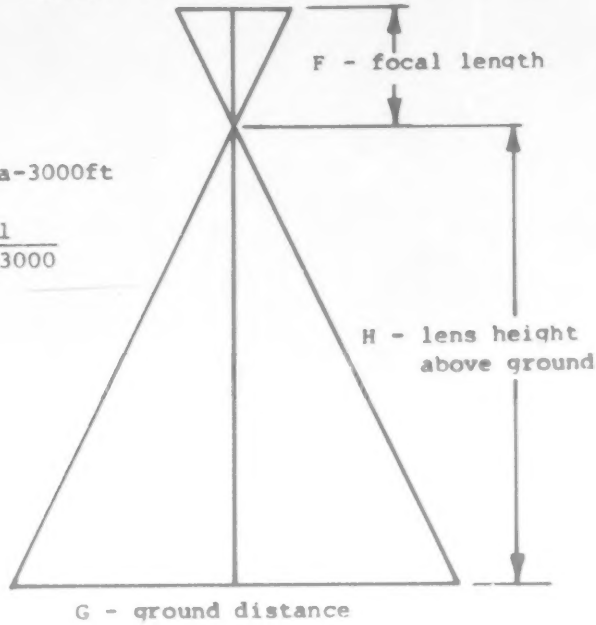
a) Determine the representative fraction, if the focal length is 8.25 in and the lens height above the ground is 7500 ft.

b) What flight altitude (above sea level) must be maintained to obtain a specified natural scale of 1 to 13000 assuming a focal length of .6875 ft and an average ground elevation (above sea level) of 3000 ft.

1. Solution:

a) $\frac{F}{H} = \frac{1}{x}$ or $\frac{(8.25\text{in})\left(\frac{1\text{ ft}}{12\text{in}}\right)}{7500\text{ ft}} = \frac{1}{x}$ so $(.6875\text{ft})(x) = 7500\text{ft}$

then $x = \frac{7500\text{ft}}{.6875\text{ft}} = 10909.$ so $\frac{1}{x} = \frac{1}{10909}$.



b) Let a = flight altitude, then H = a-3000ft

$\frac{F}{H} = \frac{1}{x}$ because $\frac{.6875\text{ ft}}{a - 3000\text{ ft}} = \frac{1}{13000}$

$a - 3000\text{ ft} = (.6875\text{ ft})(13000)$

$a - 3000\text{ ft} = 8937.5\text{ ft}$

$a = 11937.5\text{ ft}$

2. Given two stations of altitude 3625 and 3690 feet respectively that are known to be separated by a horizontal distance of 3 chains. What is the horizontal distance from the first station to one of altitude 3650 ft if the slope is uniform? Find the answer in chains and also in feet. (1 chain = 66 ft).

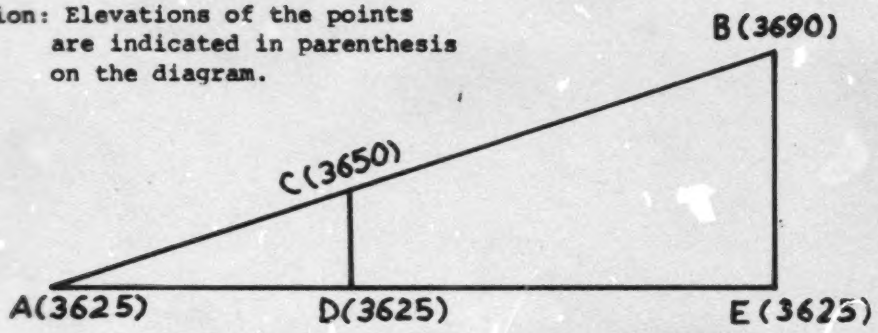
3. In obtaining information for contour mapping the following is obtained.

We start at an elevation of 1560 ft with an abney*reading of +23. Our problem is to determine the horizontal distance to a landmark of elevation 1571 ft. Determine the distance both in chains and in feet, if 1 chain = 66 feet.

* An abney is an instrument on which one unit represents a change of 1 foot elevation for each chain in horizontal distance.

Complete solutions to B problems.

2. Solution: Elevations of the points are indicated in parenthesis on the diagram.



CD = 3650 ft -3625 ft = 25 ft

BE = 3690 ft -3225 ft = 65 ft

Then since $\angle A$ is common to both triangles and angles D and E are right triangles we have $\triangle ADE \sim \triangle AEB$ and therefore:

$\frac{AD}{AE} = \frac{CD}{BE}$ so since CD = 25ft, BE = 65 ft.,

and AE = 3 chains we have

$\frac{AD}{3 \text{ chains}} = \frac{25 \text{ ft}}{65 \text{ ft}}$

$(65 \text{ ft})(AD) = 75 \text{ ft chains}$

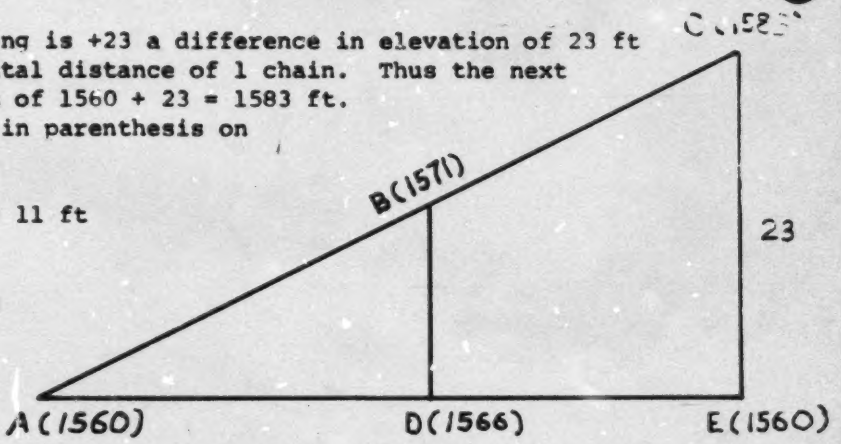
$AD = \frac{75 \text{ ft chains}}{65 \text{ ft}} = 1.15 \text{ chains or,}$

since 1 chain = 66 ft,

then $AD = (1.15 \text{ chains}) \left(66 \frac{\text{feet}}{\text{chain}}\right) = 75.9 \text{ft.}$

3. Solution:

Since the abney reading is +23 a difference in elevation of 23 ft has occured in a horizontal distance of 1 chain. Thus the next station has an elevation of 1560 + 23 = 1583 ft. Altitudes are indicated in parenthesis on the diagram.



BD = 1571 ft - 1560 ft = 11 ft

Since angle A is common to both triangles and $\angle D$ and $\angle E$ are both right angles, $\triangle ADB \sim \triangle AEC$ and thus:

$$\frac{AD}{AE} = \frac{BD}{CE}. \quad \text{So,} \quad \frac{AD}{1 \text{ chain}} = \frac{11 \text{ ft}}{23 \text{ ft}}$$

$$(23 \text{ ft})(AD) = 11 \text{ chain ft.}$$

$$Ad = \frac{11 \text{ chain ft}}{23 \text{ ft}} = .478 \text{ chains}$$

$$= (.478 \text{ chains}) \left(66 \frac{\text{ft}}{\text{chain}}\right) = 31.56 \text{ ft.}$$

A. Problems with solutions.

1. A repairman uses a white mark on the side of a tractor tire to enable him to count the number of revolutions of the wheel and thus measure distance traveled in a field. The tire on this tractor has an effective radius of 2.7 feet. How many turns of the wheel would equal a distance of 100 ft?

   Solution:

   $$C = 2\pi r = 2(3.1416)(2.7) = 16.96 \text{ ft.}$$

   $$\frac{100 \text{ ft.}}{\frac{16.96 \text{ ft.}}{\text{turn}}} = (100 \text{ ft.}) \left(\frac{1 \text{ turn}}{16.96 \text{ ft.}}\right) = 5.9 \text{ turns}$$

2. Sugar beets are thinned to 10 inch spacing in a 22 inch row. Calculate the number of plants per acre.

   Solution:

   Area per plant: (22 inches) (10 inches) = 220 in.^2

   $$\left(\frac{1 \text{ acre}}{43{,}560 \text{ sq ft}}\right)\left(\frac{1 \text{ sq ft}}{144 \text{ sq in.}}\right) =$$

   $$\left(\frac{43{,}560 \text{ sq ft}}{\text{acre}}\right)\left(\frac{144 \text{ sq in}}{1 \text{ sq ft}}\right)\left(\frac{1 \text{ plant}}{220 \text{ sq in}}\right) = \frac{28{,}512 \text{ plants}}{\text{acre}}$$

3. A soil lab reports an available nutrient at a level of 21 parts/million. How many pounds per acre foot is this in a soil that weighs 65 pounds per cubic foot?

   Solution:

   $$1 \text{ Acre foot} = (1 \text{ Acre})\ (1 \text{ ft})\left(\frac{43{,}560 \text{ sq ft}}{\text{acre}}\right) = 43{,}560 \text{ cu ft}$$

   $$(43{,}560 \text{ cu ft})\left(\frac{65 \text{ pounds}}{\text{cu ft}}\right) = 2{,}831{,}400 \text{ lbs.}$$

   $$(2{,}831{,}400 \text{ lbs})\left(\frac{21 \text{ parts}}{1{,}000{,}000 \text{ parts}}\right) = 59.5 \text{ pounds}$$

4. A livestock feeder is made of a cylinder 10 feet high, 8 feet in diameter with a 3 foot high cone in the center to force feed out to the lower edge. The cone holds no feed. When level full of feed that has a specific gravity of 0.65 how many ton will the feeder hold? Note: 1 cubic foot of water weighs 62.43 lbs.

   Solution: Vol. $= \pi r^2 h - 1/3\pi r^2 h' = \pi(4\text{ft.})^2(10\text{ft.}) - 1/3\pi(4 \text{ ft})^2(3 \text{ ft.})$

   $$= (3.1416)(4 \text{ ft.})^2 (10 \text{ ft.}) - \frac{3.1416}{3} (4 \text{ ft})^2 (3 \text{ ft.}) =$$

   $$502.65 - 50.26 \text{ cu ft} = 452.39 \text{ cu ft}$$

   $$\text{Weight} = \frac{(452139 \text{ cu ft})\left(62.4 \frac{\text{lbs}}{\text{cu ft}}\right)(0.65)}{2{,}000 \frac{\text{lbs}}{\text{ton}}} = 9.17 \text{ tons}$$

B. Problems without solutions.

5. Calculate the cost of concrete needed to pour a 3" floor in a shed 60 feet long, and 28 feet wide. Concrete costs $8 per cubic foot. Use a 3% margin.

6. a) Find the number of acres covered by a circular sprinkling system which has a radius of 1,500 feet. b) How many gallons would be needed to apply 3" of water to this area?

7. Allowing 2 inches for rolling at the edges, how many square feet of tin are required to make 270 ft. of gutter whose cross section is a semicircle 3.6 in. in diameter?

8. A skid tank for use in a farmers truck measures five feet in diameter and is 10 ft. long. If this is filled to 85% capacity with a liquid fertilizer that weighs 9.2 pounds per gal., what is the weight of the contained fertilizer?

B. Problems without solutions, continued.

9. A glass house is 80 ft. long and 24 ft. wide, with sides 8 ft. high and the roof gable 6 ft. above the walls. How many smoke bombs of 5,250 sq ft capacity will be needed to fumigate the building? (Round off to the nearest whole no.)

10. Find the area of a roof on a shed whose width is 24 ft and center height is 5 feet if the length is 60 feet. (Assume the roof has a 1 foot overhang.)

11. A hog trough with a triangular cross section measures 15 1/4 inches across the top, 7 3/4 inches in depth and 12 ft. in length (inside measurement). How many gallons of slop will it hold?

12. What sprinkler capacity is required to apply .4 inches per hour from a sprinkler set on a 80' x 100' spacing?

B. Problems without solutions, continued.

13. What is the surface area of a platform 4 feet wide built around a 30 foot tank?

14. Calculate the load in tons of a grain truck 20 feet long with end shape of a trapizoid whose dimensions are 12 feet upper width, 8 feet deep and lower width 2 feet.

15. A cylindrical grain storage bin is 12 feet in diameter, and 20 feet high. If it is initially empty, how many minutes will it take to fill the bin if the auger delivers 13 bu/min.?

16. Calculate the cost to cover a tepee 14 feet high with canvas if the base has a 22 ft. diameter. Canvas costs $4.00 per square yard.

Complete solutions to B problems.

5. Volume = (length) (width) (thickness)

$= (60 \text{ ft.})\ (28 \text{ ft.})\ (3 \text{ inches}) \left(\frac{1 \text{ ft.}}{12 \text{ inches}}\right) = 420 \text{ cu ft.}$

$(420 \text{ cu ft}) \left(\frac{\$8.00}{\text{cu ft}}\right) (1.03) = \$3,460.80$

6. a) $A = \pi r^2 = 3.1416\ (1,500 \text{ ft.})^2 \left(\frac{1 \text{ acre}}{43,560 \text{ sq ft}}\right) = 162 \text{ acres}$

1 acre ft = 325,850 gals.

b) $(162 \text{ acres})(3 \text{ in}) \left(\frac{1 \text{ ft}}{12 \text{ in.}}\right) \left(\frac{325,850 \text{ gal.}}{\text{acre-ft.}}\right) = 13,197,000 \text{ gals.}$

7. $\frac{C}{2} = \frac{\pi d}{2} = \frac{(3.1416)\ (3.6 \text{ inches})}{2} = 5.7 \text{ inches}$

2.0 inches
7.7 inches wide

$(270 \text{ ft})\ (7.7 \text{ inches}) \left(\frac{1 \text{ ft.}}{12 \text{ in.}}\right) = 173.3 \text{ cu ft}$

8. Volume $= \frac{\pi d^2 h}{4}$

$= (3.1414)\ \frac{(5 \text{ ft.})^2}{4}\ (10 \text{ ft.}) = 196.35 \text{ cu ft}$

$(196.35 \text{ cu ft}) \left(\frac{1,728 \text{ cu in}}{1 \text{ cu ft}}\right) \left(\frac{1 \text{ gal}}{231 \text{ cu in}}\right) \left(\frac{9.2 \text{ lbs.}}{\text{gal.}}\right) (.85) = 11,486 \text{ lbs.}$

9. Volume $= \left[(24 \text{ ft.})(8 \text{ ft.}) + 1/2\ (24 \text{ ft.})(6 \text{ ft.})\right]\ (80 \text{ ft.})$

$= (192 \text{ sq ft} + 73 \text{ sq ft.})\ (80 \text{ ft.})$

$= (264 \text{ sq ft})\ (80 \text{ ft.}) = 21,120 \text{ cu ft}$

$21,120 \text{ cu ft} \left(\frac{\text{bomb}}{5,250 \text{ cu ft}}\right) = 4 \text{ bombs}$

10.

$L = \sqrt{(12 \text{ ft.})^2 + (5 \text{ ft.})^2} = \sqrt{144 \text{ sq ft.} + 25 \text{ sq ft.}} = \sqrt{169 \text{ sq ft}}$

$= 13 \text{ ft.}$

Total length (13 ft.) + (1 ft.) = 14 ft.

Area = (2) (14 ft) (60 ft.) = 1,680 sq ft

Complete solutions to B problems, continued.

11. Volume = 1/2 (15 1/4 inches) (7 3/4 inches) (12 ~~ft~~) $\left(\frac{12 \text{ in}}{1 \text{ ~~ft~~}}\right)$

= 8,509 1/2 cu in

(8,509 1/2 ~~cu in~~) $\left(\frac{1 \text{ gallon}}{231 \text{ ~~cu in~~}}\right)$ = 37 gallons

12. Volume = (length) (width) (thickness)

= (80 ft) (100 ft) $\left(\frac{.4 \text{ ~~sq~~}}{\text{hour}}\right)$ $\left(\frac{1 \text{ ft.}}{12 \text{ ~~sq.~~}}\right)$ = $\frac{267 \text{ cu ft}}{\text{hour}}$

$\left(\frac{267 \text{ ~~cu ft~~}}{\text{hour}}\right)$ $\left(\frac{1{,}728 \text{ ~~cu in~~}}{1 \text{ ~~cu ft~~}}\right)$ $\left(\frac{1 \text{ gal.}}{231 \text{ ~~cu in~~}}\right)$ = $\frac{1{,}997 \text{ gallons}}{\text{hour}}$

$\approx \frac{2{,}000 \text{ gallons}}{\text{hour}}$

13. Area of tank and platform:

$\pi \frac{d^2}{4} = \frac{(3.1416)(38 \text{ ft})^2}{4}$ = 1,134 sq ft.

Area of tank only :

$(3.1416) \frac{(30 \text{ ft.})^2}{4}$ = 707 sq ft

Area of platform = 1,134 sq ft - 707 sq ft = 427 sq ft.

14. Volume = $\left[\frac{(\text{base \#1}) + (\text{base \#2})}{2}\right]$ (height) (length)

= $\left(\frac{12 \text{ ft.} + 2 \text{ ft.}}{2}\right)$ (8 ft.) (20 ft.) = $\left(\frac{14}{2} \text{ ft.}\right)$ (8 ft) (20 ft.)

= (1,120 ~~cu ft~~) $\left(\frac{0.8035 \text{ ~~bu.~~}}{\text{~~cu ft~~}}\right)$ $\left(\frac{60 \text{ ~~lbs.~~}}{\text{~~bu.~~}}\right)$ $\left(\frac{\text{ton}}{2{,}000 \text{ ~~lbs.~~}}\right)$ = 27 ton

15. Volume = $\pi \frac{d^2}{4} h$ = (3.1416) $\left(\frac{(12 \text{ ft.})^2}{4}\right)$ (20 ft.) = 2,262 cu ft

(2,262 ~~cu ft~~) $\left(\frac{0.8036 \text{ ~~bu.~~}}{1 \text{ ~~cu ft~~}}\right)$ $\left(\frac{1 \text{ min.}}{13 \text{ ~~bu~~}}\right)$ = 140 min. = 2 hour. 20 min.

16. Surface Area = (π) (radius) (slant height)

= $\pi r \sqrt{h^2 + r^2}$

= (3.1416) (11 ft.) $\sqrt{(14 \text{ ft.})^2 + (11 \text{ ft.})^2}$

= (3.1416) (11 ft.) $\sqrt{196 \text{ sq ft} + 121 \text{ sq ft}}$

= (3.1416) (11 ft.) $\sqrt{317 \text{ sq ft}}$

= (3.1416) (11 ft.) (17.8 ft.)

= 615.12 sq ft

Cost = (615.12 ~~sq ft~~) $\left(\frac{1 \text{ ~~sq yd~~}}{9 \text{ ~~ft.~~}^2}\right)$ $\left(\frac{\$4.00}{\text{~~sq yd~~}}\right)$ = $273.38